III. NATIONAL EXAMINATION

1.QUESTIONS

2.ANSWERS.

ADVANCED LEVEL NATIONAL EXAMINATION 2008

SUBJECT: PHYSICS I

OPTION: MATHEMETICS-PHYSICS

TIME:3HOURS

INSTRUCTIONS:

You will use the following if needed:
Speed of light $c=3.0X10^{8}$ m/s
Acceleration due to the gravity $g=9.80m/s^{2}$
Charge of electron $e=1.6X10^{-19}c$
Mass of electron $me=9.11X10^{-31}kg$
Avogadro's number $NA=6.022X10^{23}/mol$
Universal's gas constant R=8.314J/mol.K
Planck's constant $=6.63X10^{-34}J.s$

SECTION A: answer all questions (55 MARKS)

1. Magnifying glass

A.Explain what is meant by a virtual image, in geometrical optics?

Illustrate your answer by describing the formation of a virtual image of real object by a thin converging lens.Draw a ray diagram showing the passage of two rays through the lens for a non axial object point.

b.Explain why such a lens can be used as a simple microscope.

2.Refraction through prism

Light which passes symmetrically through a glass prism of refractive index n and a large refracting angle A goes through at minimum deviation angle of Dmin .Derive an expression of n in terms of A and Dmin

3. Capacitance

a.What is a dielectric constant?

b.Explain the effects of a dielectric placed between the plates of a charge capacitor

c.Explain what would happen if a conductor instead of a dielectric was placed between the plates

4.Enery problems in the world

a.Explain how wind energy and biofuels are solar origin.

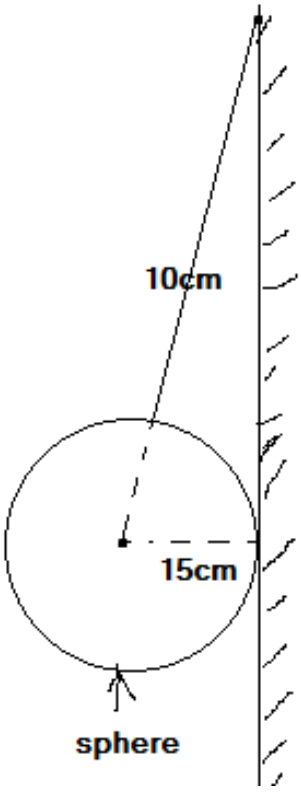
b.What is the origin of tidal energy ?Explain.

5.Kinematics

An object is thrown vertically upward.It has a speed of 10m/s when it has reached one-half its maximum height.How high does it rise?

6.Newton's law

A sphere of weight 20N and radius 15cm rests against a smooth vertically wall.The sphere is supported in this position by a string of length 10cm attached to a point on the sphere and to a point on the wall as shown in figure 1.



a.Copy the diagram and show the forces acting on the sphere

b.Calculate the reaction on the sphere due to the wall

c.Find the tension in the string.

7.Thermal effects

All thermometers make use of the change in some physical property with temperature

a.State six of these physical properties.

b.Specify the measurable physical quantity for

i.Constant volume gas thermometer.

ii.Platinum resistance thermometer

iii.Optical pyrometer

8.Superposition of harmonic waves

Two harmonic waves are described by

$$Y1=6\sin(\frac{\pi x}{15}-\frac{\pi t}{0.005})$$

$$Y2=6\sin(\frac{\pi x}{15}-\frac{\pi t}{0.005}-\phi)$$

Where x,y1 and y2 are in meters and t in seconds.

a.What is the amplitude of the resultant wave when $\phi=\frac{\pi}{6rad}$?

b.For what values of ϕ will the amplitude of the resultant wave have its maximum value?

9.Doppler Effect

a.What is meant by the Doppler effect

b.A police car sound a sirene of 1000Hz as it approaches a stationary observer at a speed of 33.5m/s.What is the apparent frequency of the siren as heard by the observer if the speed of sound in air is 340m/s.

c.Give One application of the Doppler Effect.

10. Electromagnetic Waves

a.Explain the following terms

i.Path difference and

ii.Fringe spacing with reference to the interference of light

b.Monochromatic light illuminates a narrow slit which is 4.0m away from a screen.Two narrow parallel slits o.50mm apart are placed mid way between the single slit and the screen so that interference fringes are obtained. If the spacing of five fringes is 10mm,calculate the wavelength of light.

11.Photo electric effect

Ametal of workfunction 2.5 eV is irradiated with light of an unknown frequency.The maximum of incident radiation.

b.Explain what do you understand by work function.

12.X-rays

Draw a lebelled diagram to show the main parts of a modern X-ray tube(Coolidge tube example) and explain how it operates.

13. Magnetic field of current

Two wires carry equal currents in opposite's directions.Describe the direction of the magnetic field due to the two wires at point.

a.between the wires and

b.outside the wires in a plane containing the wires.

14.Electronics

a.Explain the term doping with reference to semiconductors.

b.Explain the term P-type and n-type semiconductors.

c.give two uses of transistors.

15.Radio transmitter

Draw a block for an AM radio transmitter and explain briefly how it operates

SECTION B: Answer only THREE questions.(30 marks)

16.Optical instruments

a.Explain the difference between the terms **angular magnification** and l**inea**r **magnification**,as used about optical systems.Illustrate this,by calculating both,in the case of an object placed 5.0cm from a simple magnifying glass of length 6.0cm,assuming that the minimum distance of distinct vision for the observer is 25cm.

b.The objective and the eyepiece of a microscope may be treated as thin lenses with local length of 2.0cm and 5.0cm respectively. If the distance between them is 15cm and the final image is formed 25cm from the eyepiece,calculate the position of the object.

17.Electronics

Two small spheres of charges Q are suspended from strings of length L that are connected at a common point.One sphere has m ; the others has mass 2m.assume the angles θ1 and θ2,the strings make with the vertical are small.

a.How are θ1 and θ2 related?

b.Show that the distance r between the spheres is

$r \cong \left(\frac{3Q^2L}{8\pi\varepsilon_0 mg}\right)^{1/3}$ where ε_0 is the permittivity of free space and g is the acceleration due to gravity.

18.Dynamics of a point(work and energy)

A 12 kg block is pushed 20m up the surface of a plane inclined at an angle of 37^0 to the horizontal, by a constant force F of 120 N acting parallel to the plane. The coefficient of friction between the block and plane is 0.25

a. Compute the work done against friction. What becomes of this work?

b.Compute the change in kinetic energy of the block

c.Compute the change in potential energy of the block

19.Kinetic theory of matter

a.List the assumptions of the kinetic theory which are used in the derivation of the expression $p = \frac{1}{3}\rho c^2$ for the pressure p exerted by a gas of density ρ whose molecules have a mean-square speed c^2

B.Establish the relation between the temperature of and an ideal gas and its molecular kinetic energy.

c.A vessel of volume $50cm^3$contains hydrogen at a pressure of 1.0Pa and a temperature of 27^oc.Estimate:

i.The number molecules in the vessel.

ii.their root-mean-square speed (mass of 1 mole of hydrogen molecules=$2.0X10^{-3}$ kg/mol)

20. Electromagnetic induction

a.Explain the difference between self-induction and mutual induction

b.Describe briefly the action of a transformer.

c.Explain briefly four causes of inefficiency in a transformer.

d.Calculate the current which flows in A RESISTANCE OF 3Ω connected to a secondary coil of 60 turns if the primary has 1200 turns and is connected to a 240V a.c supply,assuming that all magnetic flux in the primary passes through the secondary and there are no other losses.

SECTION C: Answer One question(15marks)

21.Alternating current circuit

a.Distinguish between root-mean –square value and peak value of an alternating current.

b.i.Explain what is meant by resonance in an alternating current circuit containing inductance,resistance and capacitance in series.

ii.Give one practical application of this effect.

c.Explain what is meant by:

i.Band width and

ii.Quality factor of a series RLC circuit

d.Show that the quality factor $\frac{2\pi foL}{R}$,where fo is the resonant frequency

e.Show that the width Df id given by Df =R/2Πl

f.A variable capacitor is connected in series with a coil and a sinusoidal alternating supply of 20V(r.m.s) at a frequency of 50Hz.Whenthe capacitor has a value of 1.0μF,the current in the circuit reaches a maximum value 0.50A(r.m.s).

Find:

i.the resistance of the circuit

ii.the self inductance of the coil

iii.the potential difference across the capacitor.

22.Cathode rays

a.What do you understand by

i.thermoionic emission and

ii.cathode rays

b.List four main properties of cathode rays.

c.Describe briefly the functions of the main parts of a cathode ray oscilloscope.

d.An electron of energy 10KeV enters midway between two horizontal metal plates each of length 5.0cm and separated by a distance of 2cm.A potential difference of 200V is applied across the plates.A fluorescent screen is placed beyond the plates .Calculate the vertical deflection of the electron on the screen.

ADVANCED LEVEL NATIONAL EXAMINATION 2008

SUBJECT: PHYSICS II

OPTION: BIOLOGY-CHEMISTRY

TIME:3HOURS

INSTRUCTIONS:

You will use the following if needed:
Speed of light $c=3.0X10^{8}$ m/s
Acceleration due to the gravity $g=9.80m/s^{2}$
Charge of electron $e=1.6X10^{-19}c$
Mass of electron $me=9.11X10^{-31}kg$
Avogadro's number $NA=6.022X10^{23}/mol$
Universal's gas constant R=8.314J/mol.K
Planck's constant $=6.63X10^{-34}J.s$

SECTION A: Answer all question (55marks)

1.Spherical thin lenses

Explain the difference between the terms Angular magnification and linear magnification ,as used about optical systems.

2. Laws of refraction

Light is incident at an angle i1(as in figure 1)on the upper surface of a transparent plate of refractrive index n and thickness **t**,the surfaces of the plates being plane to each other.The medium on either side of the plate is air.

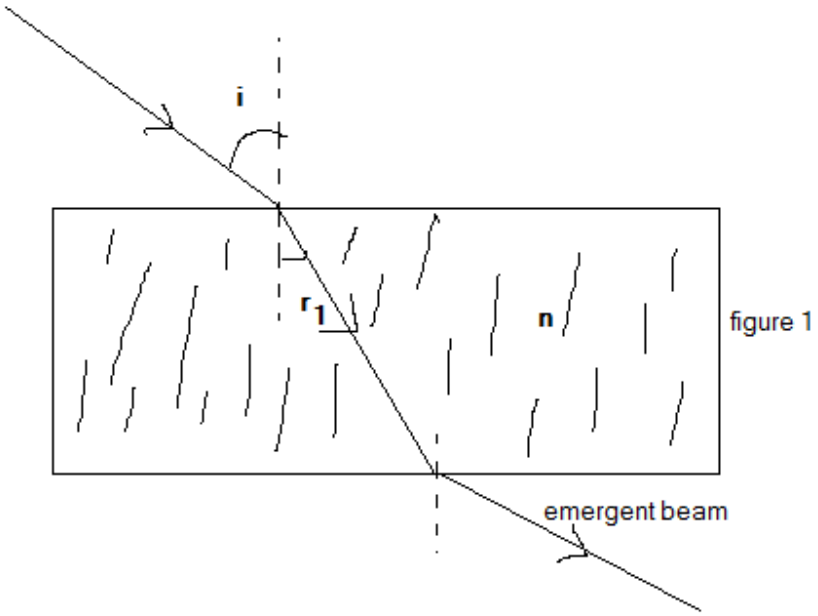


figure 1

a. Prove that the emergent beam is parallel to the incident beam

b.Derive an expression of lateral displacement in terms of i1,r1 and t.

3. Electric field lines

Sketch the electric field lines for

a.two equal positive point charges,

b.two equal and opposite point charges, and

c. a configuration of two point charges equal to +2μc and -1μc respectively. In each, comment on your answer.

4.Energy Problems in the world

a.Explain how wind energy and biofuels are solar origin

b.What is the origin of tidal energy ?Explain.

5.Kinematics

An automobile and a truck start from rest at the same instant,with the automobile initially at some distance behind the truck.The truck has a constant acceleration of $2m/s^2$ and the automobile an acceleration of $3m/s^2$.The automobile overtakes the truck after the truck has moved 75m.

a.How long does it take the auto to overtake the truck?

b.How far was the auto behind the truck initially?

c.What is then velocity of each when they are abreast?

6.Inelastic collision:

a.An empty freight car of mass 10,000kg rolls at 2m/s along a level truck and collides with a loaded car of mass 20,000kg,standing at rest with brakes released.If the cars couple together, find their speed after the collision?

7.Thermal Effects

The melting point of gold is 1064^{o}c and the boiling point is 2660 ^{o}c

a.Explain point

b.boiling point

b.Express these temperatures in kelvins.

c.Compute the difference of the temperatures in celcius degress and Kelvin degrees and compare the two numbers.Explain the difference the two scales.

8.Propagation of waves

The displacement y gives a wave traveling in the x-direction at time t is

$y = a \sin\left[2\pi\left(\frac{t}{0.1} - \frac{x}{2.0}\right)\right]$meters.

Find i.the period of the wave

ii.the velocity of the wave

iii.the direction in which the wave is traveling.

9.Sound waves

What are the first two successive resonance lengths of a closed pipe containing air at 27^0c for a tuning fork of frequency 341Hz?Take the speed of sound in air at $0\ ^0$c to the be 330m/s.

10.Interference of Light

a.Explain the following terms:

i.Path difference and

ii.fringe spacing with reference to the interference to the interference of light.

b.In Young's double-slit experiment the fringe separation observed using yellow light was found to be 0.275mm.The yellow lamp,giving a wavelength 5.55 $x10^{-7}$m is replaced by a purpose one giving wavelength 4.00$x10^{-7}$m in the violet and 6.00 $x10^{-7}$m in the red.The remainder of the apparatus is undisturbed.Calculate:

i.the distance between the fringe formed by the violet light.

ii.the distance between the fringe formed by the red light.

11.Photoelectric emission

State the conditions under which photoelectric emission occus

12.Laser

a.Distinguish between spontaneous-emission and stimulated emission.

b.Give two uses of semiconductor lasers.

13.Cathode rays

Describe briefly,with the aid of a labeled diagram,the functions of the main parts of a cathode ray oscilloscope

14.Electronics

a.Explain the term doping with reference to semiconductors.

b.Explain the term p-type and n-type semiconductors.

c.Give two uses of transistors.

15.Radio receiver

Draw a block diagram for a simple radio receiver and explain briefly how it operates.

SECTION B: Answer any THREE questions(30 marks)

16.Direct current

a.What is meant by electromotive force of a battery?

b.What factor affect the resistance of a conductor ?

c.Do the resistance of all materials increase with the temperature rise? Give some examples to justify your answer.

d.In the circuit in figure 2,the voltmeter V has a resistance of 400Ω.

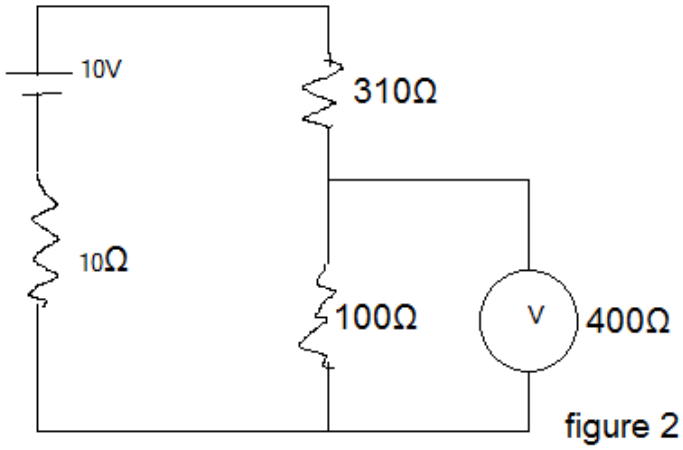


figure 2

i.Find the reading of the voltmeter.

ii.Calculate the power dissipated in the 100Ω resistor.

17.A block having a mass of 2kg is projected up a long 30^{o}c incline with an initially velocity of 22m/s.The coefficient of friction between the block and the plane is 0.3

a.Find the friction force acting on the block as it moves up the plane.

b.How long does the block move up the plane?

c.How far does the block move up the plane?

d.How long does it take the block to slide from the position in part(c) to its starting point?

e.With what velocity does it arrive at this point?

18.Electromagnetic induction

a.Explain the difference between self-induction and mutual induction

b.Give one applivation of electromagnetic induction and one application of mutual induction.

c.Draw a labeled diagram of an induction coil rotating in a uniform magnetic field and derive an expression of induced emf.

d.A transformer is designed to work on a 240V;600W supply.It has 300 turns in the primary and 200 turns in the secondary and its efficient is 80%.Calculate the current in the secondary.

19.Kinetic theory of matter

a. List the assumptions of the kinetic theory which are used in the derivation of the expression $p = \frac{1}{3}\rho c^2$ for the pressure p exerted by a gas of density ρ whose molecules have a mean-square speed c^2

b.Establish the relation between the temperature of and an ideal gas and its molecular kinetic energy.

c.A vessel of volume 50cm^{3}contains hydrogen at a pressure of 1.0Pa and a temperature of 27^{o}c.Estimate:

i.The number molecules in the vessel.

ii.their root-mean-square speed (mass of 1 mole of hydrogen molecules=2.0X10^{-3}

kg/mol)

20. .Alternating current circuit

a.Distinguish between root-mean –square value and peak value of an alternating current.

b.i.Explain what is meant by resonance in an alternating current circuit containing inductance,resistance and capacitance in series.

ii.Give one practical application of this effect.

c.A variable capacitor is connected in series with a coil and a sinusoidal alternating supply of 20V(rms) at a frequency of 50Hz.When the capacitor has a value of 1.0 μF,the current in the circuit reaches a maximum value of 0.50A(rms).

Find i.the resistance of the circuit

ii.the self inductance of the coil

iii.the potential across the capacitor

SECTION C: Answer One question(15marks)

21.Refracting through prism

a.i.state the laws of refraction.

ii.What is meant by critical angle?

b.Monochromatic light is incident at angle of 38^{o}con a glass prism of refractive index 1.50.The emergent light glazes the surface of the prism as shown in figure 3.

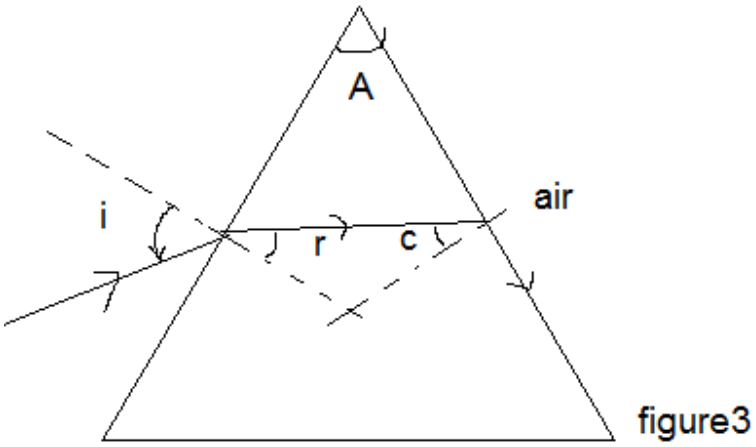


figure3

i.calculate the angle of refraction.r.

ii.Find the critical angle ,C for the glass-air interface

iii.Find the refractive angle ,A, of the prism

c.i.For a ray of light passing through a prism,what is the condition for minimum deviation to occur?

ii.Derive an expression of angle of minimum deviation,δ,in terms of angle of incidence I and refractive angle A.

iii.If the angle of minimum deviation in part (c)ii above,is 41^{o} for a glass prism of refractive angle 60^{o},find the refractive index of glass.

22.X-rays

a.What are the differences and analogies between x-rays and cathode rays?

b.Draw a labeled diagram to show the main parts of a modern x-ray tube(Coolidge tube from example) and explain how it operates

c.An x-rays tube operates at 30Kv and the current through it is 2.0mA .Calculate:

i.the electrical power in put

ii.the number of electron striking the target per second

iii.the speed of the electrons whenthey hit the target

iv.The lower wavelength limit of the x-rays emitted.

ADVANCED LEVEL NATIONAL EXAMINATION 2009

SUBJECT: PHYSICS

COMBINATIONS: -PHYSICS-CHEMISTRY-MATHS:PCM

-PHYSICS-CHEMISTRY-BIOLOGY:PCB

-MATHS-PHYSICS-GEOGRAPHY:MPG

-MATHS-PHYSICS-COMPUTER SCIENCES:MPC

TIME: 3 HOURS

INSTRUCTIONS:

Non programmable scientific calculators may be used.

Assume where necessary that:

Acceleration due to gravity ,g=9.8m.s^{-2}

Radius of the earth,R=6.4Mo^{6}m

Specific heat of water =4200J.Lg^{-1}.K^{-3}

Tan(a+b)=tan a+tan b/(1-tan a tan b)

SECTION A: answer all questions (55 MARKS)

1.a.What is a fibre

Optic cables? Explain the principle of fibre optics.

b.Give three advantages of a fiber optic cable over electrical wire.

2.a.Distinguish between hypermetropia and myopia

b.How can the defects be corrected?

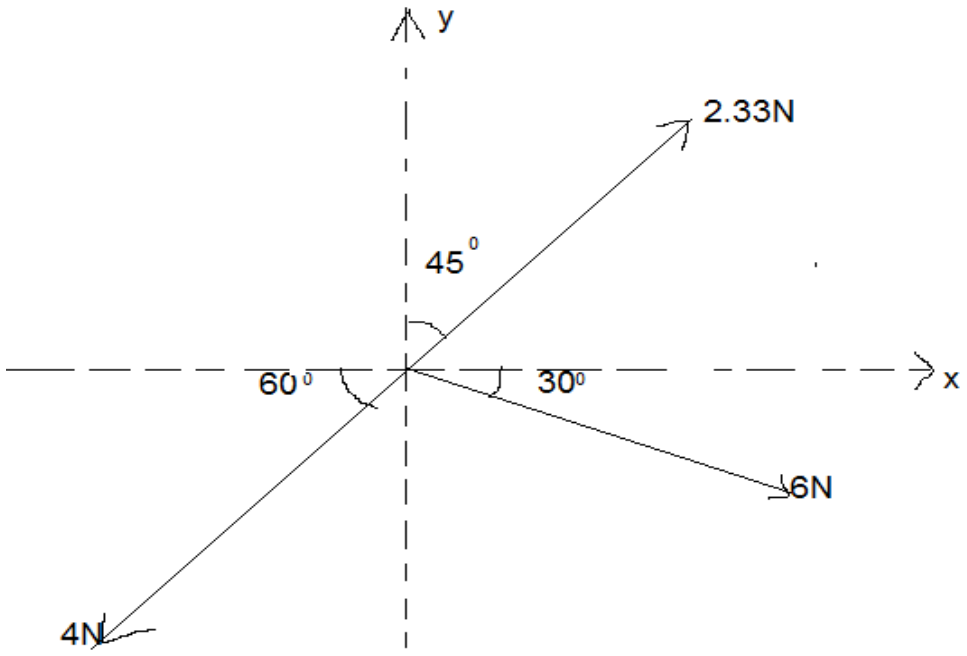
3.What are the advantages and disadvantages of wind power energy?

4.A tower is 90 m high.A particle is dropped from the top of the tower while at the same time another object is projected upward from the foot of the tower.Both objects meet at a height of 30m.Find the velocity with which the second object is projected upward

5.Discuss the advantages and disadvantages of friction.

6.a.State the conditions under which a rigid body is in equilibrium under the action of coplanar forces.

b.Forces of 2.83 N,4.00N Aand 6.00 N act on an object O as shown in figure 1 below.



Find the resultant force on the object

7.a.What is surface tension?

b.State and explain three surface tension examples

8.a.What do you understand by"coherent sources"

b.State the conditions for interference

9.Is light a wave or a particle?Explain your answer giving examples

10.a.What is sound?

b.Find the temperature at which the velocity of sound in air becomes 1.5 times its value at 0^0c.

11.In a simple model of hydrogen, an electron of mass m and charge-e is considered to move in a nearly circular orbit about a proton

a.Write down the expression for the electric force on the electron and show that the electric energy of the electron is

$e^2/8\varepsilon_o r$ where r is the radius of the orbit and ε_o is permittivity of free space.

12.a.What is X-radiation?

b.Distinguish between hard x-rays and soft X-rays.

What precautions can you take to avoid dangers of X-rays?

13.a.What is photoelectric effects?

b.Give and explain Einstein's equation for photoelectric effect.

14.a.What is a laser?

b.Draw a well labeled digram to show the main components of a laser.

15. a.What is a zener dioxide ?Draw its voltage current characteristic.

b.What do you understand by zener Breakdown and zener voltage?

SECTION B: Answer only THREE questions(45 marks)

16.a.Explain what you understand by the terms refraction and reflective index?

b.i.A glass block of refraction index n_g is immersed in a liquid of refractive index n_1.A ray of light is partially reflected and refracted at the interface such that the angle between the reflected ray and the refracted ray is 90^0.show that $n_g = n_1 \tan\alpha$ given that n_1=1.33,find n_g and the angle of incidence at the liquid glass interface.

ii.When the procedure in (i) above is repeated with the liquid removed (but the angle between the refrlected and the refracted rays remain 90^o),the angle of incidence increases by 8^0.Given that n_1=1.33 ,find n_g and the angle of incidence at the glass interface.

17.a.State in coulomb's law of electrostatics.

b.The two points charges q1=-3.0 nc and q2=+7.0nc are placed at a distance of 5cm apart.At which line joining them is the electric field zero?

18.Read the passage below and answer the questions that follow

"satellites which orbit 22,238miles(35,788km) above the earth's equator are said to be in geostationary orbit.Most telecommunication satellites are in this type of orbit.Other satellites are in solar orbit only a few hundrends of miles above the earth.These are said to be in Low earth Orbit.These are mainly military satellites which because of their low orbit can see things in great detail"

a.What is the difference between an artificial and a natural satellite of the earth?

b.Briefly explain three benefits of artificial satellites.

c.Describe what each of the following words used in the passage mean:

i.Geostationary

ii.Low earth orbit

d.Establish an expression for the velocity of geostationary satellites interms of altitude h,earth's radius R and the acceleration due to gravity at the earth's surface g and then find its numerical value.

19.A potential difference of 10V is applied at the ends of metal of across-sectional area $10^{-6}m^2$ and 1km length.

a.Sketch a diagram of this problem and it show the direction of the electric field,current density,electric current and mobile charge carrier's motion in the conductor.

b.Find out the magnitude of the electric field in the conductor.

c.Calculate the current density and electric current if the resistance of the conductor is $1.75 \times 10^{-8}\Omega.m$

d.Calculate the resistance of the conductor.

e.Sketch a graph of resistivity as a function of temperature for

i.metals

ii.Semi-conductor and

iii.Super-conductors

20.a.Explain why high voltages are needed for long distance power transmission.

a.Explain two advantages of alternating current over direct current power transmission.

b.A transformer connected to an a.c supply of peak voltage 240 V,is to supply a peak voltage of 9V to a mini lighting system of resistance of 5Ω .Calculate:

i.The ratio of primary to secondary turns.

ii.The r.m.s current supplied by the secondary turns.

iii.The average power delivered to the lighting system.

ADVANCED LEVEL NATIONAL EXAMINATION 2010

SUBJECT: PHYSICS

COMBINATIONS: -PHYSICS-CHEMISTRY-MATHS:PCM

-PHYSICS-CHEMISTRY-BIOLOGY:PCB

-MATHS-PHYSICS-GEOGRAPHY:MPG

-MATHS-PHYSICS-COMPUTER SCIENCES:MPC

TIME: 3 HOURS

INSTRUCTIONS:

You will use the following if needed:
Speed of light $c=3.0X10^{8}$ m/s
Acceleration due to the gravity $g=9.80m/s^{2}$
Charge of electron $e=1.6X10^{-19}c$

Mass of electron me=$9.11X10^{-31}$kg
Avogadro's number NA=$6.022X10^{23}$/mol
Universal's gas constant R=8.314J/mol.K
Planck's constant =$6.63X10^{-34}$J.s
Permitivity of free space εo=8.854×10^{-12} $C^2.N^{-1}.m^{-2}$

SECTION A: answer all questions (55 MARKS)

1. a.What is telescope?

B.Explain three main uses of telescopes

2. Explain with reason whether the potential energy in the following cases increases or decreases:

a. A spring is compressed

b. A spring is stretched

c.Two dissimilar charges are brought near each other

d.A body taken away against the gravitational force

e.Air bubble rises up in water.

3. Two particles are moving with constant speed V such that they are at a constant distance d apart and their velocities are always equal and opposite. After what time they return to their initial positions?

4. When three concurrent forces act on a body which in in equilibrium,the resultant of the two forces should be equal and opposite to the third force. Prove this statement.

5.1.5litres of water from a kettle at 90^0c is mixed with a bucket of cold water(10 liters at 10^0c) to warm it up for washing a car. Find the temperature of the mixed water, assuming no significant loss during the mixing.

Specific heat capacity of water is c=4.2 $kJ.kg^{-1}.{}^0C^{-1}$

6.a.What is capillary actions?

B.Give four examples of phenomena in everyday life in which capillary action occurs.

7.a.If pendulum clock is taken to a mountain top, does it lose or gain time, assuming it is correct at a lower elevation? Justify your answer.

b.Why are soldiers marching on a suspended bridge advised to go out of steps?

8.a.What are nodes and antinodes?

b.Do the above in (a) coincide with pressure nodes and antinodes?

c.In terms of wavelength λ,what is the separation of a node from the nearest antinode?

d.What is the phase difference between points separated by λ/10 in stationary waves?

9.Two sound waves originating fron the same source, travel along different paths in air and then meet at a point.If the source vibrates at frequency of 1KHz and one path is 83 cm longer than the other,what will be the nature of interference?

(The speed of sound in air is 332m/s)

10.a.Protons are accelerated from rest by a potential difference of 4.00KV anc strike a metal target.A proton produces one photon on impact,what is the minimum wavelength of the resulting x-rays?

b.How does your answer compare to the minimum wavelength if 4.00kV electrons are used instead?

c.Why do x-ray tubes use electrons rather thatn protons to produce x-rays?

11.The human eye is most sensitive to green light of wavelength 505nm.Experiments have shown that when people are kept in a dark room until their eyes have adapted to the darkness, a single photon of green light will trigger receptor cells in the rods of the retina.

a.What is the frequency of this protons?

b.How much energy(in joules and electron volts) does it deliver to the receptor cells?

c.To appreciate what a small amount of energy this is ,calculate how fast a typical bacterium of mass 9.5 x 10 $-^{12}$ g would move if it had much energy

12.A coil 4.00 cm in radius, containing 500turns, is placed in a uniform magnetic field that varies with time according to $B=0.012t+3.00^{-5}\ t^4$,where B and t are expressed in tesla and seconds respectively.The coil is connected to a 600Ω resistor and its plane is perpendicular to the magnetic field.You can ignore the resistance of the coil.

a.Find the magnitude of the induced e.m.f as a function of time.

b.What is the current in the resistor at time t=5.00s?

13.a.what is anaerobic digestion ?

b.Explain why each of terms biogas and digestate and give some of their uses.

14.You have two lightweight metal spheres,each hanging from an insulating nylon thread.One of the spheres has a net negative charge,while the other sphere has no net charge.

a.If the spheres are close together but do not touch,will they

i.Attract each other?

ii.Repel each other ? or

iii.Expert no force on each other ?

Explain your answer.

b.you now allow the two spheres to touch.

Once they have touched ,will the two spheres

i.Attract each other?

ii.Repel each other?

iii.or exert no force on each other ?Explain your answer.

15.You have a series circuit consisting of a 200Ω resistor,a 0.400H inductor and an **u** source of voltage amplitude of 30.0V and angular frequency of 250 rad/s.

a.What is the current amplitude in the circuit ?

b.What is the phase angle ϕ of the source voltage with respect to the current?

Does the source lag or lead the current?

SECTION B: Answer only THREE questions(45 marks)

16.a.What do you understand by the power of a lens?

What is its physical meaning ?

What is the unit of the power of a lens ?

b.What is an equivalent lens?

c.Prove that for a combination of two thin lenses (kept co-axially in air) of local lengths **f1** and **f2** separately by a distance **d ,**the focal length of the combination is given by

$$\frac{1}{f} = \frac{1}{f1} + \frac{1}{f2} - \frac{1}{f1\,X\,f2}$$

17. a.Distinguish between elastic collision and inelastic collision.

B.Suppose two ball A and B of masses m1 and m2 are moving initially(in the same direction)along the same straight line with velocities **u1** and **u2** respectively. The two balls collide. Let the collision be perfect elastic. After collision, suppose **v1** is the velocity of A and **v2** is velocity of B along the same straight line.

Prove that

$$v1 = \frac{(m1 - m2)u1}{m1 + m2} + \frac{2m2u2}{m1 + m2} \; and \; v2 = \frac{(m2 - m1)u2}{m1 + m2} + \frac{2m1u2}{m1 + m2}$$

c.A ball of 0.1kg makes an elastic head –on collision with a ball of unknown mass that is initially at rest.If the 0.1kg ball rebounds at one third of its original speed,what is the mass of the other ball ?

18.a.What is a dipolar transistor ?

b.Sketch the circuit diagram of

i.a PNP transistor and

ii.an NPN transistor connected to two voltage sources in common base configuration.For each case,show the direction of currents.(The emitter,base and coolector currents are denoted by $\mathbf{I_E}$,$\mathbf{I_B}$ and $\mathbf{I_C}$ respectively).

c.Give the signs of various currents and voltages in the normal operation of a transistor of a transistor by filling the following table.

	I_E	I_B	I_C	V_{EB}	V_{CE}	V_{CB}
PNP						
NPN						

(V_{EB}, VCB and V_{CE} are the voltage drops from the emitter to base, collector to base and collector to emitter respectively.)

19.In the Bohr model, the speed of the electrons in a hydrogen atom in the n level is given by $v_n=e^2/2\varepsilon onh$ where e is the electron charge,h is the planck constant and εo is the permittivity of free space.

a.Sketch the diagram of the electron motion and show the direction of its position vector and velocity.Show also the direction of the electric force acting on the electron

b.Show that the radius of the electron orbit is given by

$r_n = \varepsilon o n^2 h^2/\pi m e^2$where m is the mass of the electron.

c.Calculate the orbital period in each of the n=1,2 and levels.

d.The average lifetime of the first excited level of a hydrogen atom is 1.0×10^{-8}s.

How many orbit does an electron in the n=2 level complete before returning to the ground level?

20.a.State Kirchoff's junction and loop rules.

b.Give the sign conventions for(i) electromotive forces and (ii) voltage drops across resistor in applying the loop rule.

c.In the circuit shown in figure below,the resistance R is 5Ω and e.m.f ε=20V.

i.Find the reading of the idealized ammeter and voltmeter.

ii.Copy the diagram and show the true direction of currents in the branches.

ADVANCED LEVEL NATIONAL EXAMINATION 2011

SUBJECT: PHYSICS

COMBINATIONS: -PHYSICS-CHEMISTRY-MATHS:PCM

-PHYSICS-CHEMISTRY-BIOLOGY:PCB

-MATHS-PHYSICS-GEOGRAPHY:MPG

-MATHS-PHYSICS-COMPUTER SCIENCES:MPC

-PHYSICS-ECONOMICS-MATHEMATICS :PEM

TIME: 3 HOURS

INSTRUCTIONS:

You will use the following if needed:
Speed of light c=3.0X10^{8} m/s
Acceleration due to the gravity g=9.80m/s^{2}
Charge of electron e=1.6X10^{-19}c
Mass of electron me=9.11X10^{-31}kg
Avogadro's number NA=6.022X10^{23}/mol
Universal's gas constant R=8.314J/mol.K
Planck's constant =6.63X10^{-34}J.s
Permitivity of free space εo=8.854 x 10 $^{-12}$ C^{2}.N^{-1}.m^{-2}
Heat of combustion of gasoline : Lc=46 x 10^{6} J/
Speed of sound in air :v=340m/s
Mass of the earth M=6 X 10^{24} kg
Gravitational constant G=6.672 X 10 $^{-11}$ Nm^{2}/kg
Radius of the earth : M=6 x 10 ^{24}kg
Atmospheric pressure 1 atm= 1.03 X 105 pa
Resistivity of constantan ρ=47x10^{-8}Ωm

SECTION A: Attempt all question (55marks)

1. The period of the vibration P of a star under its own gravitational attraction is given by $p = \frac{2\pi}{\sqrt{G\sigma}}$ where σ is the mean density of the star and G is the gravitational constant. Show that this relation is dimensionally correct.

2. The refractive index of the core and cladding of an optical fiber are 1.5 and 1.3 respectively .calculate the critical angle at the interface.

Calculate the critical angle at the interface.

3. A photocell is connected in series with a direct current supply a micro-ammeter.

(a) Sketch a labeled circuit using these components and indicate the positive and negative terminals of supply and the meter.

(b)Explain why the arrangement would not work if the supply were connected the wrong way round.

4. The thermionic diode and triode have been replaced by semiconductor diode and transistor. State four advantages of using transistor and a semiconductor diode.

5. (a) Define capacitance of an insulated conductor.

(b)A parallel plate capacitor is to be made by sandwiching a 0.1mm thick piece of mica between two metal plates. If mica has a relative permittivity of 7, what area of plates is required to achieve a capacitance of 250 nF?

6. (a) What is the principle of superposition as applied to wave motion ?

(b)Two loudspeakers emit 340 HZ sounds of equal amplitude 4×10^{-6}m. The speakers are 3m apart and face each other.

i) What is the wavelength of the sound?

ii) Ignoring the reduction of amplitude with distance from each speaker, state the amplitude A_1 of sound half way between the speakers.

7. (a) state the principle of conservation of angular momentum.

(b)A constant torque of 200 Nm turns a wheel about its centre the moment of inertia about this axis 100kgm^2.

I. Determine the angular acceleration of the wheel.
II. Find the angular velocity gained in 4 seconds.

8. The capacity of storage battery, such as those used in automobile electrical systems, is rated in ampere –hours (A.h).

a) What total energy in joule can be supplied by a (12v, 60ah). Battery if internal resistance is negligible?
b) What mass of gasoline has total heat of combustion equal to energy obtained in part (a) above?

9. (a) Define the linear magnification of a lens.

(b) A slide of dimension 2cm by 2 cm produces a clear image of dimension 80 cm by 80 cm on a projector screen.

I. Determine the linear magnification of the lens.
II. Calculate the focal length of the projector lens if the screen is 82 cm from the slide.

10. (a) Define resistivity of a material

(b) Calculate the resistance per meters length of constantan wire of diameter 0.4mm.

11. (a) what is meant by velocity?

(b)A resultant force of 12 N acts for 5 s on a mass.

I. What is the change in momentum of the mass?
II. Determine the final velocity of the mass.

12. An empty cylindrical canister 1.5m long and 90cm in diameter

Is tobe filled with pure oxygene at 22^0 c to store in space station?

To hold as much gas as possible, the absolute pressure of the oxygen will be 21 atm .The molar mass of oxygen is 32g/mol.

(a)calculate the volume of the cylinder.

(b)How many moles of oxygen does this canister hold ?

(c)for someone lifting this canister , by how many kilograms does this gas increase the mass to be lifted?

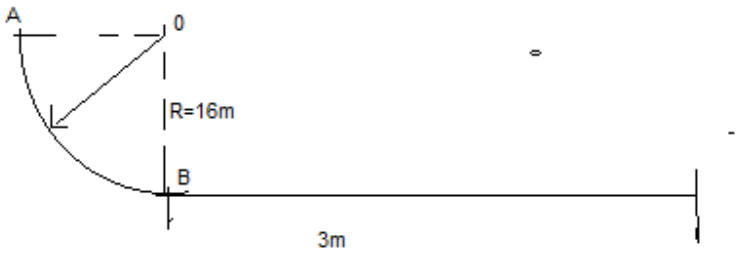
13. A particle with initial velocity v= ($5x10^3$m/s) j enters a region of uniform electric and magnetic field. The magnetic fiel in the region is B=(1T)K. calculate the magnitude and direction of electric in the region if the particle is to pass through undeflected (the resultant force is zero),for a particle of positive charge .you can ignore the weight of the particle.

14.A beam of light is incident on a liquid of 1.4 refractive index .the refracted rays are completely linear polarized.

(a)what is polarization?

(b)what is the angle of refraction of the beam?

15.I n truck-loading station at a post office, a small 0.2kg package is released from rest at point A on a track that is one-quarter of a circle with radius 1.6m,so the package can be treated as a particle.It slides down the track and reches point B with a speed of 4.8m/s.From point B,it slides on a horizontal surface a distance of 3m to point C where it comes to rest.



a.What is the coefficient of kinetic friction on the horizontal surface?

b.How much work is done on the package by friction as ut slides down the circular arc from A to B.

SECTION B: Answer only THREE questions (45 marks)

16.a.

i.Show that if a electron moves at right angle to a magnetic field the path is a circle.

ii.Show also that the electron suffers no force if it moves parallel to the magnetic field.

b.An electron starts from rest and in accelerated through a potential difference of 200V.

i.What is the electron's kinetic energy at the end of the end of the accelerated?

ii.At what speed will it be moving after the acceleration?

C.The electron now enters a region in which the magnetic field strength is 0.2 T and at 90 degree to the electron's path.

i.What is the force on the electron?

ii.What is the radius od curvature of the path followed?

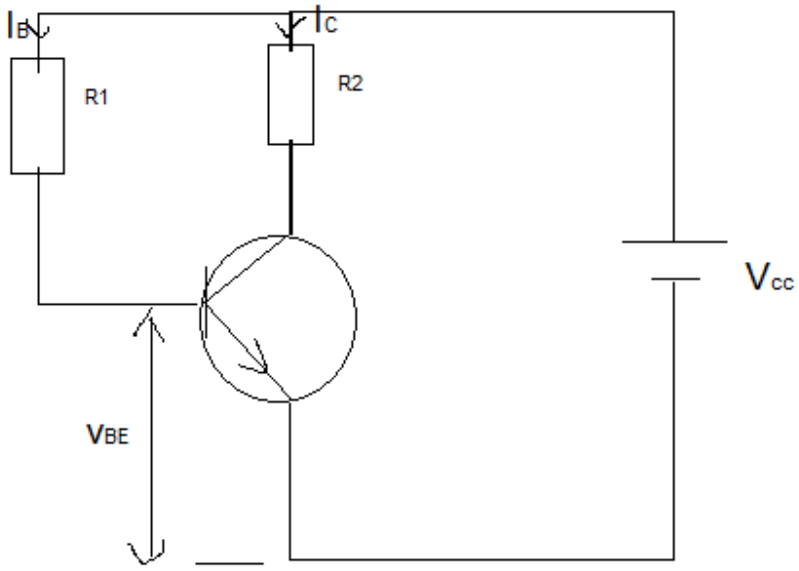
iii.How long would the electron have to remain in the magnetic field for it to end up travelling at 90 degree to its initial direction?

17.a.Describe a semiconductor diode.

b.Draw a labeled circuit which can be used to produce a full wave rectification including the source of alternating current, a bridge connected diodes and a load.Explain its functioning.

c.In the junction transistor voltage amplifier circuit of figure 2:

R_1=100Ω,R_2=IK Ω V_{CC}=6v, V_{BE}=0.6V ,current gain H_{FE}=60



Calculate:

i.The voltage cross R1

ii.IB

iii.IC

iv.The voltage across R2

v.The voltage across the collector-emitter.

18.a.

i.State the law of universal gravitation

ii.Define the gravitational field

iii.Use your answers i) and ii) to show that the magnitude of the gravitational field at the earth's surface is $\frac{GM}{R^2}$ where M is the mass of the earth,R radius of the earth and G is the gravitational constant .

b.What is meant by gravitational potential ?Use the data below to show that its value at the earth's surface is -62.55 MJ/kg?

c.A communication satellite occupies an orbit such that its significance of its period and show that the radius R_0 of the orbit is given by:

$$R_O = \sqrt[3]{\frac{GMT^2}{4\pi^2}}$$

Where T is the period of revolution.

19.The radii of curvature of the surfaces of a thin converging meniscus lens are R1=12cm and R2=28cm.The index of refraction is 1.6

a.i.Compute the focal length of the lens

ii.Determine the position of the image of an object in the form of an arrow 5mm tall,Perpendicular to the lens axis,45cm to the left of the lens.

iii.Compute the size of the lens.

b.A second converging lens with the same focal length is placed 3m to the right of the first .

i.Find the position and the size of the final image.

ii.Is the final image erect or inverted with respect to the original object?

iii.Compute the size of the final image.

20.A wheel changes its angular velocity with a constant acceleration while rotating a fixed axis through its center.

a.Show that the change in the magnitude of the radial acceleration during any time interval of the point on the wheel is twice the product of the angular acceleration, the angular displacement,and the perpendicular distance of the point from the axis.

b.The radial acceleration of a point on the wheel that is 0.25m from the axis changes from 25m/s2 to 85m/s2 as the wheel roptates through 15rad.Calculate the tangential acceleration of this point.

c.Show that the change in the wheel's kinetic ebergy during any time interval is the product of the moment of inertia about the axis, the angular acceleration and the angular displacement.

d.During the 15 rad angular displacement of part(b) above, the kinetic energy of the wheel increases from 20J to 45 J.What is the moment of inertia of the wheel about the rotation axis?

II.ANSWERS

2008 PHYSICS I

SECTION A

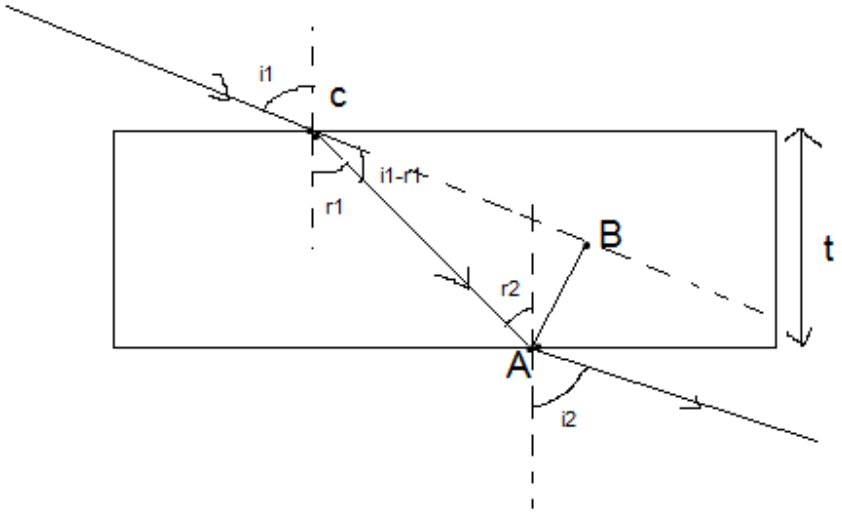
1. The angular magnification or magnifying power of a optical instruction is defined by the equation(1.05 if formulae only):

   M=$\frac{\beta}{\alpha}$ where β= angle subtended at the eye by the image formed when using the instrument

   α = angle subtended by an object placed at the near point of an unaided eye

   Linear magnification is the ratio of the image distance $LM = \frac{v}{\mu} = \frac{hi}{ho}$

2.



a.

$$r_2 = r_1$$
$$\sin i_2 = n \sin r_1 \ (1)$$
$$\sin i_2 = n \sin r_1 \ (2)$$

Dividing equation (1) by equation (2) we get

$$\frac{\sin i_1}{\sin i_2} = 1$$
$$\sin i_1 = \sin i_2$$
$$i_1 = i_2$$

Therefore, the emergent ray is parallel to the incident ray

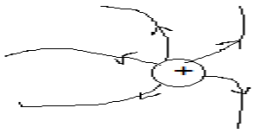
b. $\sin(i_1 - r_1) = \frac{AB}{AC}$

The related displacement $AB = ACsin(i_1 - r_1)$

$$cos\ r_1 = \frac{t}{AC}$$
$$AC = \frac{t}{\cos r_1}$$
$$AB = \frac{t \sin (i_1 - r_1)}{\cos r_1}$$

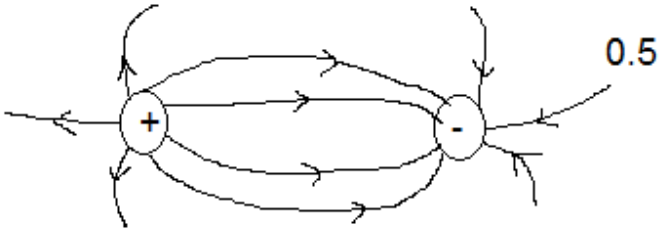
3.

a. Electric field lines of two equal and positive points charges




The number of lines leaving the two points charges is the same

b. Electric field lines of two equal and opposite point charges



The number of liner leaving the positive equal the number terminating at the negative charge

c.

The two lines leave the charge +2 for every one that terminates on -1

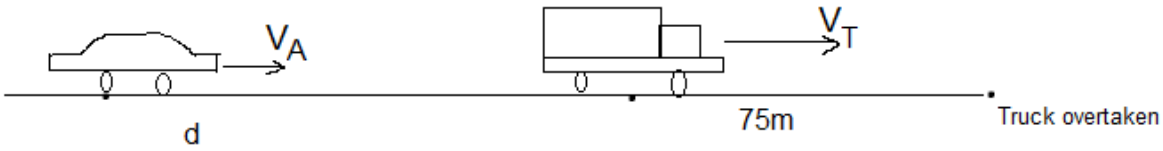
4.

a.

- Winds are due to convection currents in air causes by uneven heating of the earth's surface by the sum
- Bio-fuels are stored solar energy in form of starch and cellular made under sum's action in green plants by photosynthesis

b. The origin of tidal energy is the moon tides are caused by the gravitational pull of the moon on the oceans

5.



a.

$$a_T = 2\,m/s^2$$
$$a_A = 3m/s^2$$
$$x_T = \frac{1}{2}a_T t^2 = 75$$
$$t = \sqrt{\frac{2x_T}{a^2}}$$
$$t = \sqrt{\frac{2 * 75}{2}} = 8.7sec$$

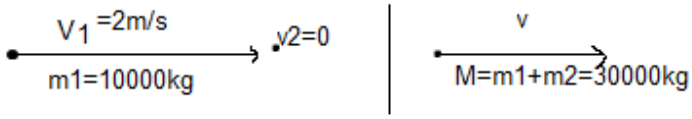
b. $x_A = \frac{1}{2}a_A t^2 = \frac{1}{2}(3)(8.66)^2 = 112.5m$

$$x_A = x_T + d \quad d = x_A - x_T = 37.5m$$

c. $V_A = a_A t = 3(8.66) = 26.0\,m/s$

$$V_T = a_A t = 2(8.66) = 17.32\,m/s$$

6.



a.

Total momentum before collision=total momentum after collision

$$10000V_1 + 0 = 30000V$$

$$V = \frac{1}{3}V_1 = \frac{2}{3} = 0.67\,m/s$$

b.

$$10000V_1 - 20000V_2 = 0 \qquad V_2 = \frac{1}{2}V_1 = 1\,m/s$$

7.

a.

i. Melting point is the constant temperature at which a substance changes from solid state to liquid state at a given pressure

ii. Boiling point is the constant temperature at which a liquid is converted into gas at a given pressure.

b. $T_K = T_C + 273$

$$1064℃ = 1337K$$

$$2660℃ = 2933K$$

c. Difference of temperature in Celsius degrees:

$$2660℃ - 1064℃ = 1595℃$$

Difference of temperature is Kelvin degrees:

$$\Delta\theta℃ = \Delta TK = 1596K$$

The two scales differ only in choice of the zero point: the ice 273k corresponds to 0℃ and of the steam point 373k which corresponds to 100℃.

8. $y = a \sin\left[2\pi(\frac{t}{0.1} - \frac{x}{2.0})\right]$

i. Period T=0.1sec

ii. Wavelength $\lambda = 2.0m$ $\quad V = \frac{\lambda}{T} = \frac{2}{0.1} = 20\,m/s$

iii. The wave is travelling from left to right

9. The speed of sound in gas is given by

$V = \sqrt{\frac{\gamma RT}{M}}$ where M is the molar mass of the gas and γ is the ratio of the principal heat capacities $T_1 = (27 + 273)k = 300k \qquad V_1 = K\sqrt{T_1}$

$$T_o = 273k \;\; V_o = k\sqrt{T_o}$$

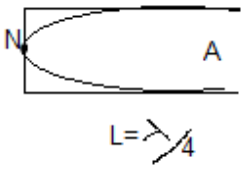
$$\frac{V_1}{V_2} = \sqrt{\frac{T_1}{T_o}}$$

$$V_1 = V_o\sqrt{\frac{T_1}{T_o}} = 330\sqrt{\frac{330}{273}}$$

$$V_1 = 346\,m/s$$

- For the first resonance lengthL_1, the closed pipe emits its fundamental frequency $f_1 = 341Hz$ the wavelength of the fundamental note is given by

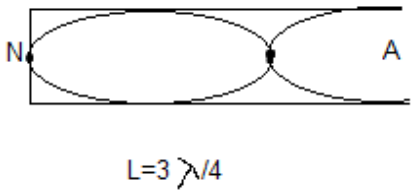
$$\lambda_1 = \frac{V_1}{f_1} = \frac{346}{341} = 1.01m$$



$$L_1 = \frac{\lambda_1}{4} = \frac{1.01}{4} = 0.254m$$

- The second resonance length $L_2 = \frac{3}{4}\lambda_1$

$$L_2 = \frac{3}{4}(1.01) = 0.757m$$



10.

a.

i. The path difference is the difference in distance travelled by two waves from their sources to a given point on the pattern

ii. The fringe spacing is the distance between two adjacent bright (or dark) fringes

b.

i. The fringe spacing

$y = \frac{d}{a}\lambda \quad \frac{d}{a} = \frac{y_y}{\lambda_y} = \frac{0.275*10^{-3}}{5.00*10^{-7}} = 550$

For the violet light

$$y_V = \frac{d\lambda_V}{a} = 550(4 * 10^{-7}) \;\; y_V = 0.22mm$$

ii. For the red light

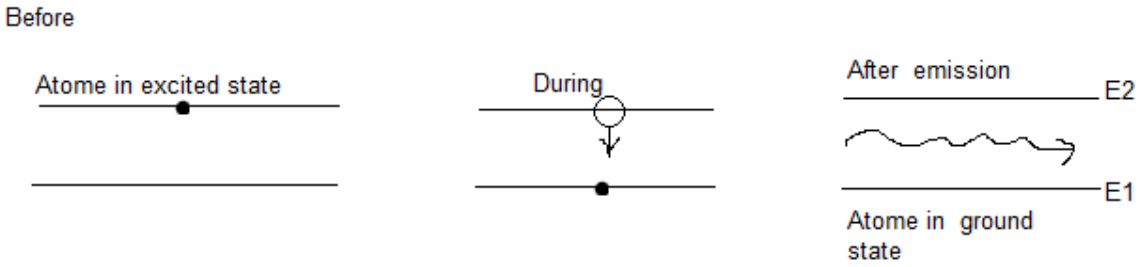
$$y_r = \frac{d}{a}\lambda_r = 550(4 * 10^{-7}) = 0.330mm$$

11.

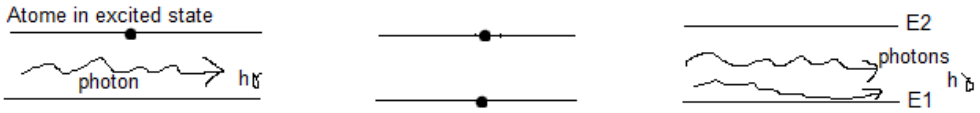
- The number of photoelectrons emitted per second is proportional to the intensity of the incident radiation
- The photoelectrons are emitted with a range kinetic energies from zero up to a maximum increases and is independent of the radiation
- For a given metal there is a certain minimum frequency of radiation called **threshold frequency** below which no emission occurs irrespective of the intensity of the radiation

12.

a. Spontaneous emission is the process by which a light source such an atom, molecule in an excited state undergoes a transition to the ground state (lower level) and emits photons.

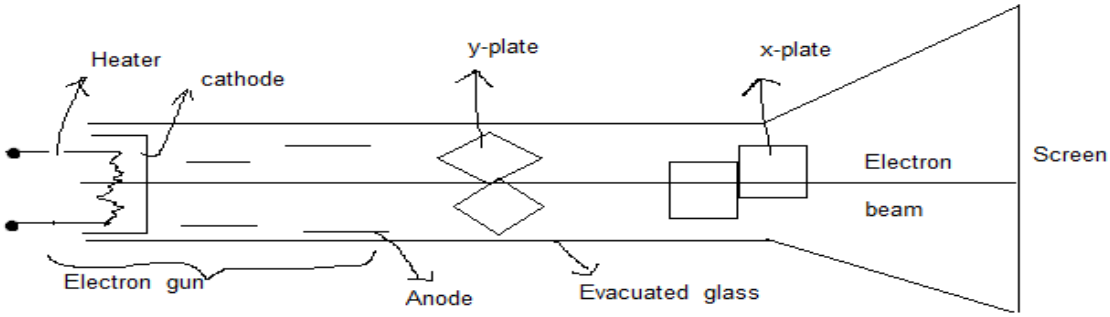


- Stimulated emission is the processes by which when perturbed by photon, matter may lose energy resulting in creation of other photons.
- The second photon is created with the same phase, frequency, polarisation and direction of travel as the original



b. Semi conductor laser are used
   - In optical fibre communication system
   - In high-speed computer printers
   - In optical CD(reader)

13. The main parts of ray oscilloscope are electron given, the deflecting system and the fluorescent screen



1) Electron given

This is an electrode assembly for producing a narrow beam of cathode rays. The gun comprises an indirectly heated cathode, one grid and anodes

2) Deflecting system

The beam from cathode passes first between a pair of horizontal metal plates (the y-plates) whose electric field causes vertical deflection and then between two vertical plates (the x-plates) that cause horizontal deflection when a p.d is applied to them.

3) Fluorescent screen

The inside of the wide end of the tube is coated with a phosphor which emits light when struck by moving particles

14.

a. Doping is a process by impurities are introduced in a semiconductor, in order to increase its conductivity

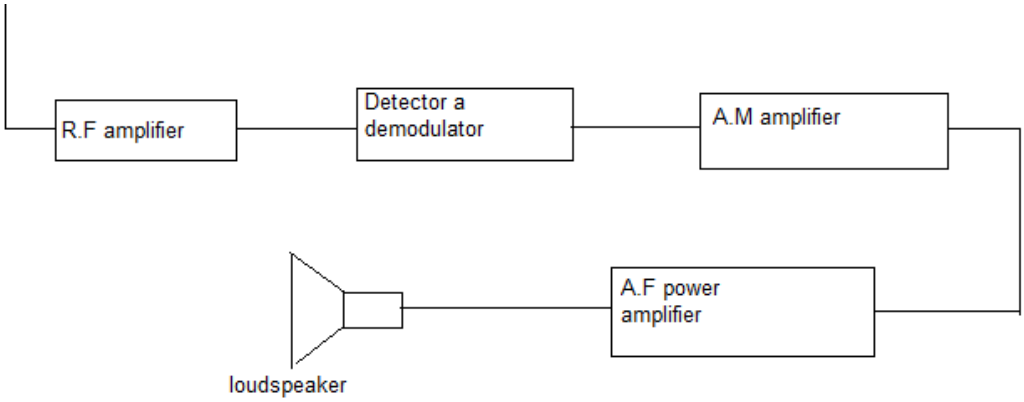
b.

- P-type conductor is a doped semiconductor in which the conductor occurs chiefly due to the positive charge carriers
- N-type semiconductor is a doped semiconductor in which the main charge carriers are negative electrons

c.

- A function transistor in the common emitter can act as voltage amplifier
- Transistors are used as switches in many electronic circuit

15. Radio receiver



The wanted signal from the aerial is selected and amplified by the radio frequency amplifier which is a voltage amplifier with a turners circuit The radio frequency is next separated from the modulated radio frequency by the direction and amplified by radio frequency power amplifier to operate the loudspeaker

SECTION B

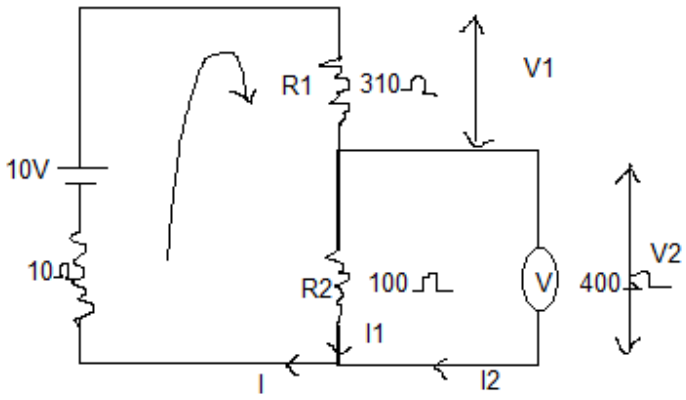
16.

a. The electromotive force of a battery is the energy (chemical) converted into electrical energy when unit charge passes through it or the e.m.f of a battery is equal to the voltage across its terminals when the current is zero
b. Factors affecting the resistance of a conductor:

- Resistivity of the conductor i.e properties of the material
- Length
- Cross sectional area
- The temperature

c. No. The resistance of metals and alloys increases with the temperature rise but the resistance of graphite, semiconductors and most non-metals decreases with temperature rise.

d.



$$I = I_1 + I_2 (1)$$

i. *Loop A:* $10I + 310I + 100I = 10(2)$

Loop B: $400I_2 - 100I_1 = 0$ (3)

From (3) we get $I_1 = 4I_2$

Equation (1) becomes $I = 4I_2 + I_2 = 5I_2$

Introducing this is equation (2) we get: $320I + 100I_1 = 10$

$$or\ 320(5I_2) + 100(4I_2) = 10$$

$$1600I_2 + 400I_2 = 10 \quad I_2 = \frac{1}{200}A = 0.005A$$

The reading of the voltmeter is $V = 400I_2$

ii. $p_{100} = 100I_1^2$

$$I_1 = 4I_2 = 0.02A$$

$$P_{100} = 100(0.02)^2 = 0.04w$$

Or

i. $V_2 = \frac{R_2}{R_1+R_2}$

$V = \frac{400*100}{100+400}$ Where V=voltage, R_1=310Ω,

R_2=effective resistance

$$R_2 = \frac{400 * 100}{100 + 400} = 80\Omega$$

$$V_2 = \frac{80}{100 + 400} * 10 = 2v$$

$$R_T = 10 + 80 + 310 = 400\Omega$$

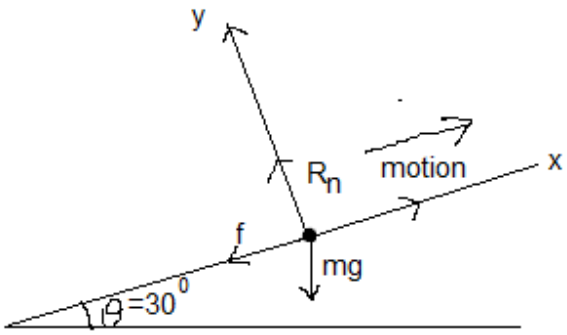
Voltmeter reading =2v

ii. $V = IR$

$$I = \frac{V}{R} = \frac{2}{100} = 0.02A \quad P = I^2R = 0.02^2 * 100 = 0.04w$$

17.

a.



The reaction of the plane is $R_N = mg\cos\theta$

The function force is $f = \mu_o R_N = \mu_o\, mg\, cos\theta$

$$f = (0.3)(2)(9.8)cos30° = 5.1N$$

b. $-mg\, sin\theta - f = ma \quad a = \frac{-mg\sin\theta - f}{m}$

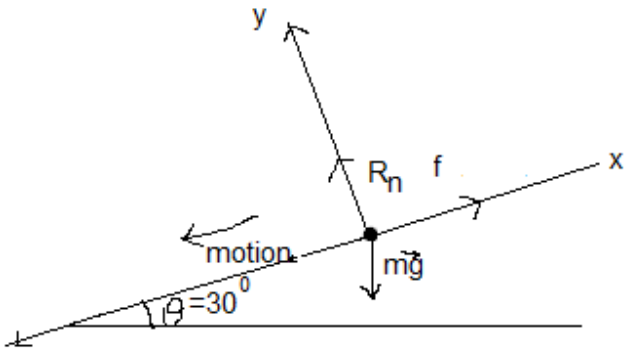
$$a = \frac{-(2)(9.8)\sin 30° - 5.1}{2} = -7.45\, m/s^2 \quad V = V_o + at \quad where\ V = 0, t = \frac{V_o}{a}$$

$$t = \frac{-22}{-7.45} = 2.95sec$$

c. $V^2 - V_o^2 = 2ax$

$$x = \frac{V^2 - V_o^2}{2a} = \frac{0 - 22^2}{2(-7.45)} = 32.5m$$

d.



$$mg\ sin\theta - f = ma$$

$$a = \frac{mg\ sin\theta - f}{m} = \frac{(2)(9.8)sin30° - 5.1}{2} = 2.35\, m/s^2$$

$$x = \frac{1}{2}at^2 \qquad t = \sqrt{\frac{2x}{a}} = \sqrt{\frac{2(32.5)}{2.35}} = 5.26sec$$

e. $V = at = (2.35)(5.26) = 12.36\, m/s$

18.

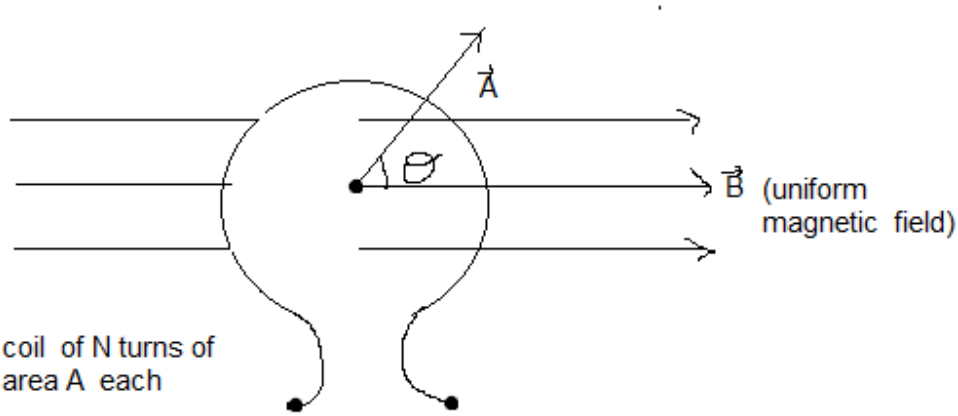
a.

- In self induction, current changing in a coil or circuit can induce an e.m.f in the same coil or circuit.
- In mutual induction, current changing in one coil or circuit (the primary) can induce an e.m.f in a neighbouring coil or circuit (the secondary)

b.

- ➢ Application of electromagnetic induction :
  - Electric bell
  - Electromagnetic breaks using Foucault current
- ➢ Production of alternating current by rotating a magnetic field within a stationary coil.
- ➢ Application of mutual induction transformer

c.



The coil rotates with a constant angular aclavity w with a uniform magnetic field B.

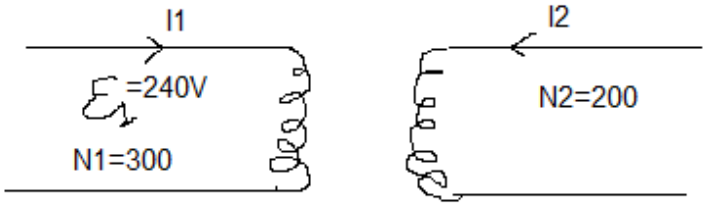
The total magnetic flux through the coils.

$\varphi_B = NBA\cos\theta = NBA\cos wt$

Where $\theta = wt$ angle between B and the normal to the plane e.m.f in the coil is :

$$\varepsilon = \frac{d\varphi_B}{dt} \quad or\ \varepsilon = NBAw\sin wt$$

d.



Power input $P_1 = \varepsilon_1 I_1 = 600 \quad I_1 = \frac{p_1}{\varepsilon_1} = \frac{600}{240} = 2.5A$

Power output $P_2 = 0.80P_1 = 0.80 * 600 = 480w$

$$\varepsilon_2 = \varepsilon_1 \frac{N_2}{N_1} = 240\left(\frac{200}{300}\right) = 160V$$

$$P_2 = \varepsilon_2 I_2$$

$$I_2 = \frac{P_2}{\varepsilon_2} = \frac{480}{160} = 3A$$

19.

a. Assumption of the kinetic theory of gases :

- The number of molecules is large, and the average separation between them is large compared with their dimension
- The molecules undergo elastic collisions, with each other
- The intermolecular forces are negligible except during collision
- Te molecules obey Newton's law of motion but the individual molecules move in random fashion
- The time occupied by a collision is negligible composed with the time spent by a molecule between collision

- Between collisions a molecule moves with uniform velocity
- The volume of the molecules themselves can be neglected compared with the volume occupied by the gas

b. $P = \frac{1}{3}\rho C^{-2}$ $\rho = \frac{Nm}{V}$,

Where

Nm=the total mass of gas

N=number of molecules of gas

M=mass of a molecule of gas

$$P = \frac{1}{3}\frac{NmC^{-2}}{V} \qquad PV = \frac{1}{3}\frac{NmC^{-2}}{V}$$

N=n NA where n is the number of moles of moles of gas and NA is Avogadro's number

$$PV = \frac{1}{3}nNAmC^{-2}$$

According to the equation of state for an ideal gas, $PV = nRT$

We have $\frac{1}{3}nNAmC^{-2} = nRT \quad or\ \frac{1}{2}mC^{-2} = \frac{3}{2}\frac{R}{NA}T$

The molecular kinetic energy is $\frac{1}{2}mC^{-2} = \frac{3}{2}KT$

Where $K = \frac{R}{NA}$ the Bolt Mann's constant and R is is the universal gas constant

c.

i. $n = \frac{PV}{RT}$ T=27+273=300k

$$N = nNA = NA\frac{PV}{RT}$$

$$N = \frac{(6.023 * 10^{23})(1.0)(50 * (10^{-2})^2)}{(8.314)(300)}$$

$$= 1.21 * 10^{16}\ molecules$$

ii. $\rho = \frac{Nm}{V}$ $m = \frac{\mu}{NA}$ $where\ \mu\ is\ the\ mass\ of\ one\ mole$

$$\rho = \frac{16N}{NAV} = \frac{(2.0 * 10^{-3})(1.21 * 10^{16})}{(6.022 * 10^{23})[50 * (10^{2})^{3}]} = 0.8 * 10^{-6}\ kg/m^3$$

$$C^{-2} = \frac{3P}{\rho}$$

$$the\ rms\ speed\ is \sqrt{C^{-2}} = \sqrt{\frac{3p}{\rho}}$$

$$\sqrt{C^{-2}} = \sqrt{\frac{3(1.0)}{0.8 * 10^{-6}}} = 1.94 * 10^3\ m/s$$

20.

a. The rms value of an alternating current is the steady direct current which ($I_{rms} = \frac{I_o}{\sqrt{2}}$) converts electrical energy to other forms of energy in a given resistance at the same rate as the alternating current.
The peak value of an a.c is the maximum value of a.c in the positive a negative direction

b.

i. The impedance of an RLC series circuit is given by $Z = \sqrt{\quad + (LW + \frac{1}{LW})^2}$ and the current is given by $I = \frac{\varepsilon_o}{Z} = \frac{\varepsilon_o}{\sqrt{R^2 + (LW + \frac{1}{lw})^2}}$
Where Eo is the p.d applied to the circuit amplitude I varies with the frequency. Its maximum value occurs at a frequency at which the impendence Z is minimum $Z = R^1 (or\ X_L = X_c)$
This peaking of the current amplitude at a certain frequency is called **resonance**.

ii. In radio receiver and television receivers, the resonant frequency of the circuit is turned (by varying a capacitor) so the frequency of the signal desired to be detected

c.

i. At resonance Z=R

$$I = 0.50A \qquad I = \frac{E}{A} \qquad R = \frac{E}{I} = \frac{20}{0.5} = 40A$$

ii. $f = \frac{1}{2\pi\sqrt{LC}}$ $L = \frac{1}{4\pi^2 fc} = \frac{1}{4\pi^2(50)(1.0*10^{-6})} = 10.13H$

iii. $V_c = \frac{I}{cw} = \frac{I}{2\pi fc} = \frac{0.5}{2\pi(50)(1.0*10^{-6})} = 159.15v$

SECTION C

21.

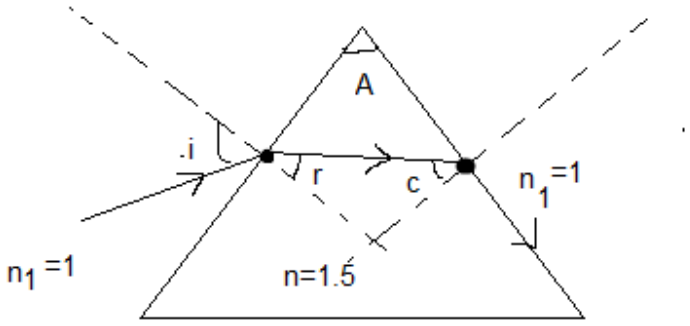
a.

- Smell`s law of refraction: fro two particular media, the ratio of the sine of the angle of incidence to the sine of the angle of refraction is constant

$$\frac{sini}{\sin r} = constant$$

- The refracted ray is in the same plane as the incident ray and the normal to the medium at the point of incidence but on the opposite site of the normal from the incident ray.

b.



i. $n = \frac{\sin i}{\sin r}$ $\sin r = \frac{\sin i}{n} = \frac{\sin 38^\circ}{1.5} = 0.41044$

$r = 24.23^\circ$

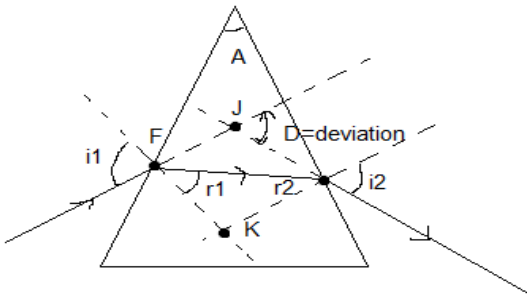
ii. $n = \frac{\sin 90^\circ}{\sin c}$ $\sin c = \frac{1}{n} = \frac{1}{1.5} = 0.6667$ $c = 41.8^\circ$

iii. $A = r + c = 24.23^\circ + 41.8^\circ = 66^\circ$

c.

i. Minimum deviation occurs when the angle of emergence of the ray from the second face equals the of incidence of the ray on the first face

ii.



$$Angle\ JFG = i_1 - r_1$$
$$Angle\ JGF = i_2 - r_2$$
$$Angle\ FJG = 180° - (i_1 - r_1 + i_2 - r_2)$$
$$Angle\ of\ deviation\ D = 180° - [180° - (i_1 - r_1 + i_2 - r_2)]$$
$$D = i_1 - r_1 + i_2 - r_2 = (i_1 + i_2) - (r_1 + r_2)$$
$$Angle\ FKG = 180° - (r_1 + r_2)$$
$$In\ fig\ XFKGX, we\ have\ \ A + 90° + 180° - (r_1 + r_2) + 90° = 360°$$
$$r_1 + r_2 = A$$
$$D = i_1 + i_2 - A$$

At the minimum deviation, $i_1 = i_2 = i$ and $i_1 = r_2 = r$

$$\delta = 2i = A$$

iii. $n = \frac{\sin i}{\sin r}$ $N = \frac{\delta + A}{2}$ $and\ 2r = A$

iv. $r = \frac{A}{2}$ $n = \frac{\sin i}{\sin r} = \frac{\sin\frac{\delta+A}{2}}{\sin\frac{A}{2}} = \frac{\sin\frac{41+60}{2}}{\sin\left(\frac{60}{2}\right)} = 1.54$

$$n = 1.54$$

22.

a. I

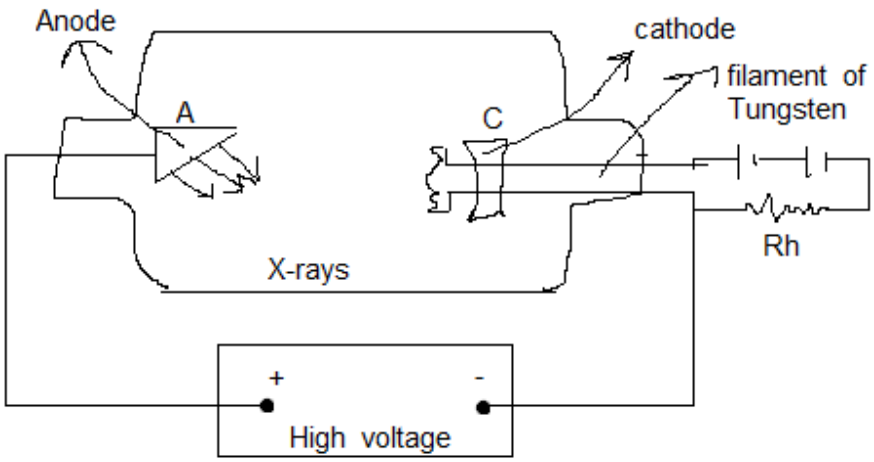
i. Analogies

- They travel in the straight lines
- They cause certain substances to fluorescent

ii. Differences

X-rays	Cathode rays
• They penetrate matter	
• They are not deflected by electric Or magnetic fields	• They are deflected by electric and magnetic field
• They ionise a gas	
• They affect a photo graphic emulsion	
• They eject electrons from matter by the photoelectric effect and other mechanism	• They produce-rays on striking matter
	• They possess kinetic energy

b.



A modern x-ray tube is highly evaluated and contains an anode and a tungsten filament connected to a cathode. Electrons are obtained from the filament by thermo atomic emission and are accelerated to the anode by a high p.d applied between anode and cathode.

c.

i. Power input : $P = VI = (30 * 10^3)(2 * 10^{-3}) = 60w$

ii. The current through the tube is given by: $n = \frac{I}{e} = \frac{2*10^{-3}}{1.6*10^{-19}} = 1.25 * 10^{16}\, electron/sec$

iii. K.e of electrons is given by:

$$\frac{1}{2}mv^2 = ev$$

$$V = \sqrt{\frac{2ev}{m}} = \sqrt{\frac{2 * 1.6 * 10^{-19}}{9.11 * 10^{-31}}} = 1.03 * 10^8\, m/s$$

iv. The lowest X-ray wavelength emitted is given by:

$$\lambda_{min} = \frac{hc}{ev} = \frac{6.63 * 10^{-34} * (30 * 10^8)}{1.6 * 10^{-19} * (30 * 10^3)} = 0.41 * 10^{-10} m$$

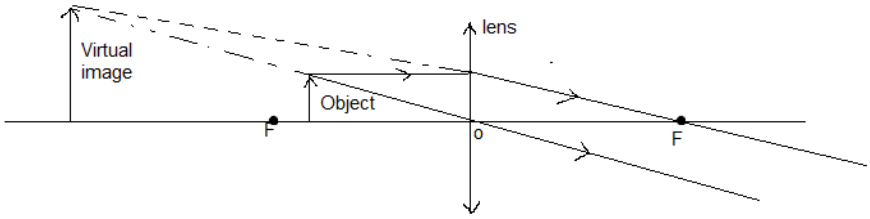
2008 PHYSICS II

SECTION A

1.

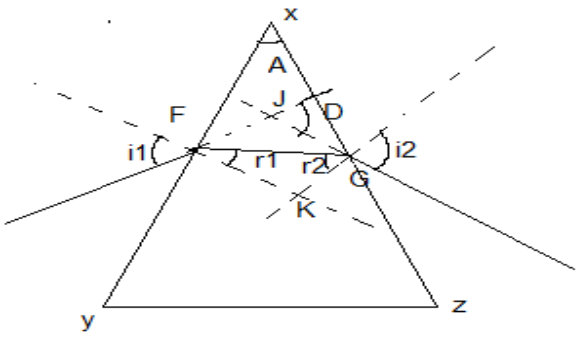
a.

- An image of an object is a virtual image when the rays of the light do not actually pass through it; they only seem to come from it. A virtual image would not be obtained on a cinema screen.
- The formation of a virtual image by a thin converging lens occurs for a real object placed inside its principal focus.



b. This lens can be used as a single microscope because it forms an upright and magnified image

2.



$$Angle\ JGF = i_2 - r_2$$
$$Angle\ FJG = 180° - (i_1 - r_1 + i_2 - r_2)$$
$$Angle\ of\ deviation\ D = 180° - [180° - (i_1 - r_1 + i_2 - r_2)]$$
$$D = i_1 - r_1 + i_2 - r_2 = (i_1 + i_2) - (r_1 + r_2)$$
$$Angle\ JFG = i_1 - r_1$$
$$Angle\ FKG = 180° - (r_1 + r_2)$$
$$In\ fig\ XFKGX, we\ have \quad A + 90° + 180° - (r_1 + r_2) + 90° = 360°$$
$$r_1 + r_2 = A$$
$$D = i_1 + i_2 - A$$

At minimum deviation angle, D_{min} the ray passes symmetrically through the prism i.e the angle of emergence of the ray from the second face equals the angle of incidence of the sang on the first face:

$$i_1 = i_2 = i \quad i_1 + i_2 - A = 2N - A \quad i = \frac{A + D_{min}}{2}$$
$$If\ i_1 = i_2, the\ r_1 = r_2 = r \quad r = \frac{A}{2}$$

The refractive index of the material of the prism, n, is given by:

$$n = \frac{\sin i}{\sin r}$$

$$n = \frac{\sin\left(\frac{A+D_{min}}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

3.

a. A dielectric constant of a material is the relative permittivity of the material i.e the ratio permittivity of free space.

b.

- A dielectric increases the capacitance of a capacitor....
- A dielectric increases the maximum operating voltage of a capacitor

c. A conductor placed between the plates of a capacitor causes a discharge of the capacitor.

4.

a.

- Winds are our to convection currents in air caused by uneven heating of the earth's surface by the sum.
- A small percentage of solar radiation is absorbed by green plants during photosynthesis and is stored in them chemical energy. Plants are a source of bio-fuels. Hence, bio-fuels are stored solar energy, in form of starch and cellulose made under sum's action in green plants by photosynthesis.

b. The origin of tidal energy is the moon. Tides are caused by the gravitational pull of the moon on the oceans.

5. The speed of the object going up is:

$$V = V_o - gt$$

Where V_o is the initial speed. The maximum light is:

$$H = V_o t - \frac{1}{2} g t^2$$

$$H = V_o \left(\frac{V_o}{g} - \frac{1}{2} g (\frac{V_o}{g})^2 \right) = \frac{V_o^2}{g}$$

The half of maximum height is:

$$\frac{H}{2} = \frac{V_o^2}{4g}$$

$$At\ \frac{H}{2}, V = 10 = V_o - gt$$

$$t_2 = \frac{V_o - 10}{g}$$

$$\frac{H}{2} = V_o t_2 - \frac{1}{2} g t^2 = \frac{V_o^2}{4g}$$

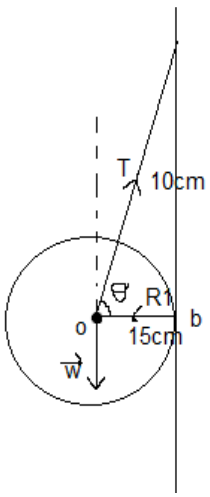
$$V_o \left(\frac{V_o - 10}{g} \right) - \frac{1}{2} g (\frac{V_o - 10}{g})^2 = \frac{V_o^2}{4g}$$

$$V_o^2 = 200$$

$$H = \frac{V_o^2}{2g} = \frac{200}{2(9.8)} = 10.2m$$

6.

a.



The forces acting on the sphere are:

- Its weight w
- Normal reaction of the wall R_N
- The tension T in the string

b. The sphere is in equilibrium:

$$w + R_N + T = o \ (1)$$

The x-component of the equation above is given by:

$$-R_N + T\ cos\theta = 0 \qquad R_N = T\ cos\theta (2)$$

The y-component of the same equation is given by:

$$w + t\sin\theta = 0 \quad w = t\sin\theta\ (2)$$

We divide the equation (3) by equation (2):

$$tan\theta = \frac{w}{R_N} \quad R_N = \frac{w}{tan\theta}$$

$$ba = \sqrt{oa^2 - ob^2} = \sqrt{25^2 - 15^2} = 2cm$$

$$tan\theta = \frac{ba}{ob} = \frac{20}{15} = \frac{4}{3}$$

$$R_N = \frac{w}{tan\theta} = \frac{20}{\frac{4}{3}} = 15N$$

c. $\cos\theta = \frac{15}{25} = \frac{3}{5}$

From equation (2) we have

$$T = \frac{R_N}{\cos\theta} = \frac{15}{\frac{3}{5}} \quad T = 25N$$

7.

a. Physical properties changing with temperature are:
   - The change in volume of a liquid
   - The change in length of a liquid
   - The change in pressure of a gas at constant volume
   - The change of a gas at constant pressure

- The change in electric resistance of a conductor
- The change in color of a very hot body

b.

i. The pressure of a fixed mass of gas
ii. The resistance of a platinum wire
iii. Monochromatic radiation from the tungsten filament lamp.

8.

a. The resistant wave function Y is given by:

$$y = y_1 + y_2$$

$$= 6\left[\sin\left(\frac{\pi x}{15} - \frac{\pi t}{0.005}\right) + \sin\left(\frac{\pi x}{15} - \frac{\pi t}{0.005} - \varphi\right)\right]$$

$$\sin a + \sin b = 2\cos\frac{a-b}{2}\sin\frac{a+b}{2}$$

$$y = 12\ cos\ {}^{\varphi}/_{2}\ sin\left(\frac{\pi x}{15} - \frac{\pi t}{0.005} - \varphi\right)$$

The amplitude of the resultant wave is

$$A = 12\ cos\ {}^{\varphi}/_{2}$$

When $\varphi = {}^{\pi}/_{6}$ $A = 12\ cos\ {}^{\pi}/_{6} = 11.6m$

b. A is maximum for $cos\ {}^{\varphi}/_{2} = \pm 1$

$$i.e\ {}^{\varphi}/_{2} = 0, \pi, 2\pi, 3\pi$$

$$\varphi = 0, 2\pi, 4\pi, 6\pi$$

$$or\ \varphi = 2k\pi \quad with\ k \epsilon\ Z$$

Or

a. $A = (A_1^2 + A_2^2 + 2A_1A_2\cos\Delta\varphi) = 11.6m$
b. A is maximum when $\cos\Delta\varphi = \pm 1$ $\Delta\varphi = 2k\pi, k \in Z$

9.

a. The Doppler effect is the change in frequency heard by an observer whenever there is relative motion between the source and observer

b. $f = f\frac{V}{V-V_o}$

$$f = 1000 * \frac{340}{340-300} = 1109.3Hz$$

c. The microwave Doppler effect is used:
   - In police radar speed checks and
   - In tracking satellites

10.

a.

i. The path difference is the difference in distance travelled by two waves from their respective sources to a given point on the pattern.

ii. The fringe spacing is the distance between two adjacent bright (or dark) fringes. Or + the path difference is the difference of optical ways for two monochromatic waves
+ The fringe spacing is the distance between centers of 2 consecutive dark or bright fringes.

b. If λ is the wavelength of the light, λ is given by:

$$\lambda = \frac{a}{d}y$$

Where y is the fringe spacing $a = 0.5mm$ is distance between two parallel slit, and $d = \frac{4.0m}{2} = 2.0m$ is the distance between the parallel slits and screen.

$$\frac{5}{2}y = 10mm \quad y = 4mm$$

$$\lambda = \frac{a}{d}y = \frac{0.5*10^{-3}}{2.0}(4 * 10^{-3}) = 10^{-6}m$$

11.

a. Einstein's equation is given by:

$$\frac{1}{2}mV_{max}^2 = hf = \varphi$$

Where $\varphi$the work function and f is is the minimum frequency of the incident radiation.

The maximum wavelength of the incident radiation is given by:

$$\lambda = \frac{c}{f}$$

$$\frac{1}{2}mV_{max}^2 = \frac{h\,c}{\lambda} - \varphi$$

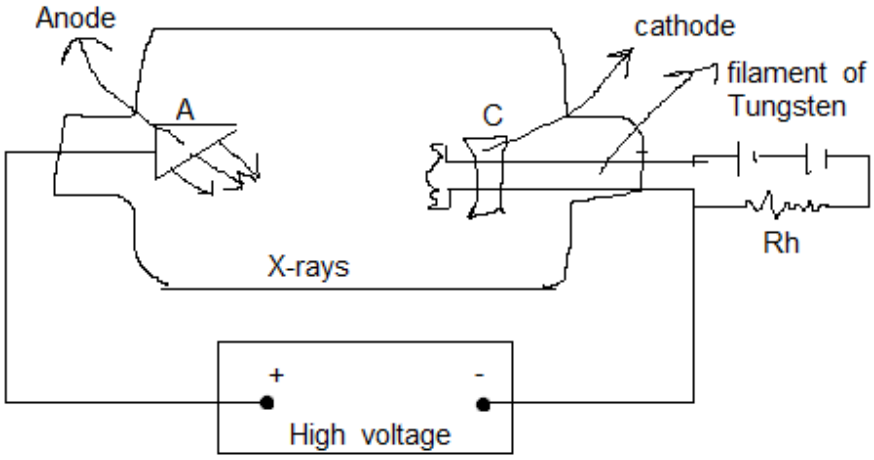
$$\lambda = \frac{hc}{\frac{1}{2}mV_{max}^2 + \varphi}$$

$$\lambda = \frac{6.63 * 10^{-34} * 3 * 10^8}{\frac{1}{2} * 9.11 * 10^{-31} * (1.14 * 10^6)^2 + 2.5 * 1.6 * 10^{-19}}$$

$$= 2.0 * 10^{-7} m$$

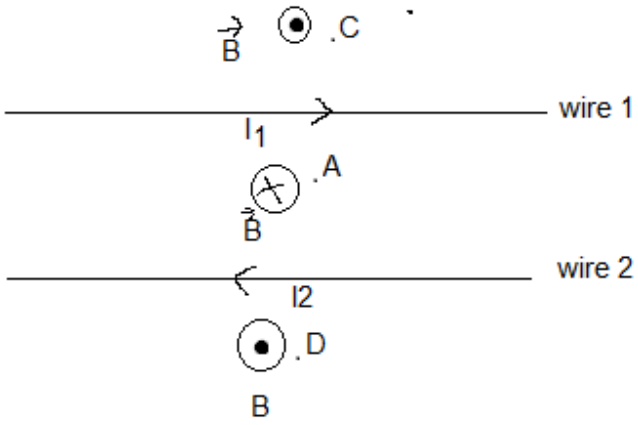
b. Work function=quantity of energy
Absorbed by an electric above which will be liberated from the surface of a metal.

12. Coolidge tube for x-rays is shown in diagram below:



A modern X-rays tube is highly evacuated and contains an anode and a tungsten filament connected to a cathode. Electrons are obtained from the filament by thermo ionic emission and are accelerated to the anode by a high potential difference applied between anode and cathode. The anode is a copper block inclined to the electron stream and having a small target of tungsten on which electrons are focused by the concave cathode.

13.



a. Between the wire (at point A for example) the resultant magnetic field is perpendicular to the plane containing the wires and directed in word the plane .

b.

- At point D, the resultant magnetic field is perpendicular to the plane containing the wires and directed outward.
- At point c, the magnetic field is perpendicular to the plane containing the wires and directed outward.

14.

a. Doping is a process by which impurities are introduced in a semiconductor, in order to increase its conductivity.

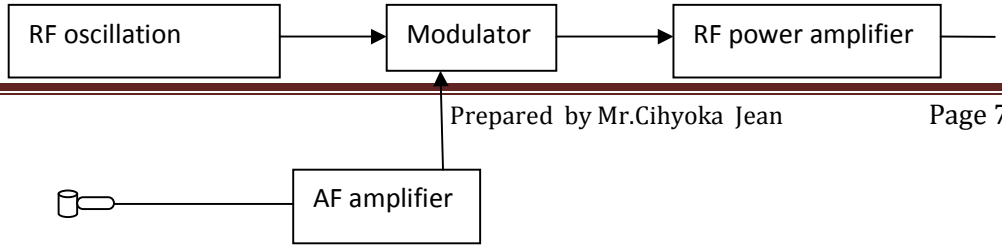
b.

- P-type semiconductor is a doped semiconductor in which the conduction occurs chiefly due to the positive charge carriers
- N-type semiconductor is a doped semiconductor in which the main charge carriers are negative electrons

c.

- A function transistor in the common emitter can act as voltage amplifier
- Transistors are used as switches in many electronic circuits

15. A block diagram for an AM radio transmitter is shown in figure below. In the modulator the amplitude of the radio frequency carrier from the radio frequency generator is varied at the frequency of the radio frequency signal from the microphone.



SECTION B

16.

a.

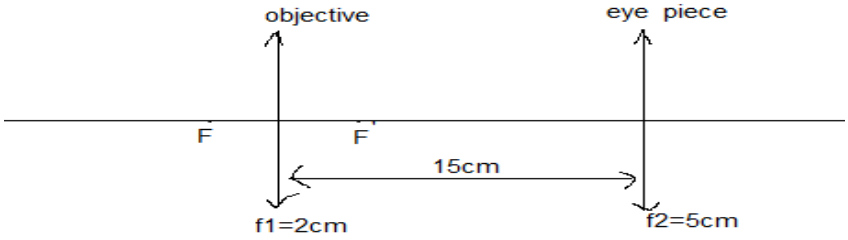
- The angular magnification or magnifying power of an optical instruction is defined by the equation $\mu = \frac{\beta}{\alpha}$
  Where
  β=angle subtend at the eye by the image formed when using the instrument
  α=angle subtended at the unpaid eye i.e without the instrument
- Linear (a lateral or transverse) magnification is the ratio of the image distance to the object distance $m = \frac{V}{\mu}$
- Angular magnification $\mu = \frac{25}{6} = 4.18$
- Distance V is given by:

$$\frac{1}{V} = \frac{1}{f} - \frac{1}{\mu}$$

$$\frac{1}{V} = \frac{1}{6.0} - \frac{1}{5.0} = \frac{1}{30} \quad V = -30cm$$

Linear magnification $m = \left|\frac{V}{u}\right| = \frac{30}{5} = 6.0$

b.



O is the position of the object, I_1 is the position of the first image and I_2 is the position of the final image, I_1 acts as the object for the eye piece and the final image I_2 is virtual.

$$\frac{1}{u_2}+\frac{1}{V_2}=\frac{1}{f_2}$$

$$\frac{1}{u_2}=\frac{1}{f_2}-\frac{1}{V_2}=\frac{V_2-f_2}{f_2V_2}$$

$$u_2=\frac{f_2V_2}{V_2-f_2}=\frac{5(-25)}{-25-5}=\frac{125}{30}=4.17cm$$

$$u_2=I_1P_2$$

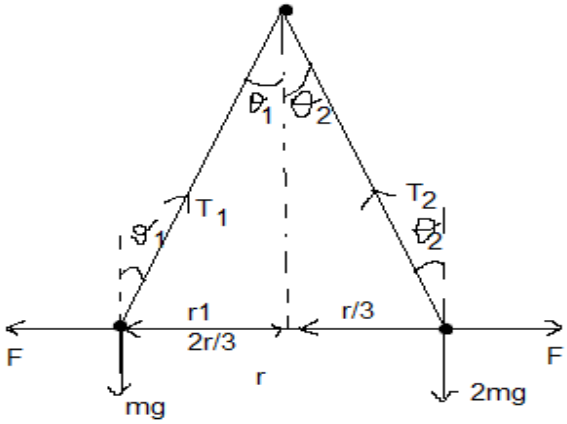
For the objective, image I_1 is real image and is placed at V_1 distance for the objective

$V_1=P_1V_1=P_1P_2-I_1P_2\ \ =15-\frac{25}{6}=\frac{65}{6}$

Hence $u_1=\frac{V_1f_1}{V_1-f_1}=\frac{2(^{65}/_6)}{\frac{65}{6}-2}=2.453cm$

The object O is about 2.453cm from the objective

17.



a. $\sin\theta_1 = \frac{r_1}{L}$ $\quad r_1 = L\sin\theta_1$

$$\sin\theta_2 = \frac{r - r_1}{L} \qquad L\sin\theta_2 = r - r_1$$

$$L\sin\theta_2 = r - L\sin\theta_1$$

$$\sin\theta_1 + \sin\theta_2 = \frac{r}{L}$$

$$\tan\theta_1 = \frac{F}{P_1} = \frac{F}{mg} = \theta_1$$

$$\tan\theta_2 = \frac{F}{P_2} = \frac{F}{2mg} = \theta_2$$

b. The electric force on each sphere is :$F = \frac{\theta^2}{4\pi\varepsilon_o r^2}$ each sphere is in equilibrium i.e $mg + F + T_1 = O$

$$mg + F + T_2 = O$$

The horizontal components of these equations are above are: $F - T_1 \sin\theta_1 = 0(1)$

$$F - T_2\sin\theta_2 = 0(2)$$

The vertical components are:

$$mg - T_1 \sin\theta_1 = 0(3)$$

$$mg - T_2\sin\theta_2 = 0(4)$$

From (1) and (3) we have:

$$\tan\theta_1 = \frac{F}{mg} = \frac{\theta^2}{4\pi\varepsilon_o mgr^2}$$

$$\tan\theta_2 = \frac{F}{2mg} = \frac{\theta^2}{8\pi\varepsilon_o mgr^2}$$

Since θ_1 and θ_2 are small

$$\text{Tan}\,\theta_1 \cong \sin\theta_1 = \frac{\theta^2}{4\pi\varepsilon_o mgr^2}$$

$$\tan\theta_2 \cong \sin\theta_2 = \frac{\theta^2}{8\pi\varepsilon_o mgr^2}$$

We found that $\sin\theta_1 + \sin\theta_2 = \frac{r}{L}$

$$\frac{\theta^2}{4\pi\varepsilon_o mgr^2} + \frac{\theta^2}{8\pi\varepsilon_o mgr^2} = \frac{r}{L}$$

$$\frac{3\theta^2}{8\pi\varepsilon_o mgr^2} = \frac{r}{L}$$

Or

$$\frac{3\theta^2 L}{8\pi\varepsilon_o mg} = r^3 \quad r = \left(\frac{3\theta^2 L}{8\pi\varepsilon_o mg}\right)^{1/3}$$

Or from fig above

$\text{Tan}\,\theta_1 = \frac{2r}{3L}$, $\tan\theta_2 = \frac{r}{3L}$ For small angle

$$\text{Tan}\,\theta_1 \cong \theta_1 = \frac{F}{mg} = \frac{2r}{3L}$$

$$\tan\theta_2 \cong \sin\theta_2 \cong \theta_2 = \frac{F}{2mg} = \frac{r}{L}$$

$$\text{Tan}\,\theta_1 + \tan\theta_2 = \frac{F}{mg} + \frac{F}{2mg}$$

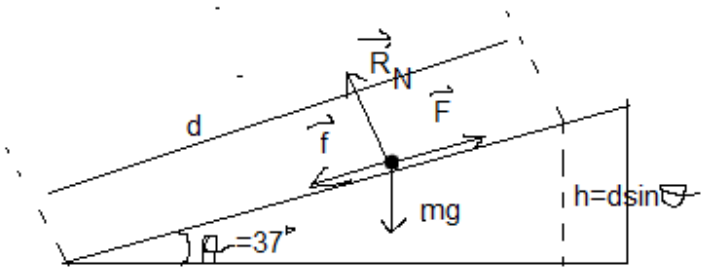
$$\frac{2r}{3L} + \frac{r}{3L} = \frac{F}{mg} + \frac{F}{2mg}$$

$$\frac{r}{L} = \frac{F}{mg}\left(1 + \frac{1}{2}\right) \quad \frac{r}{L} = \frac{3F}{2mg}$$

$$\frac{r}{L} = \frac{3}{2mg} * \frac{\theta^2}{4\pi\varepsilon_o r^2}$$

$$r^3 = \frac{3\theta^2 L}{8\pi\varepsilon_o mg} \qquad r = \left(\frac{3\theta^2 L}{8\pi\varepsilon_o mg}\right)^{1/3} (hence\ above)$$

18.



a. $R_N = mg\cos\theta$

The function face $f = \mu R_N$

$$f = \mu\, mg\cos\theta = 23.5N$$

The work done against function is

$$|wf| = +fd = \mu\, mg\cos\theta\, d$$

$$= +25(12)(9.8)(\cos 37)(20) = +470j$$

This work is converted into heat

b. In this direction of motion, we have $-mg\sin\theta - f + F = ma$

The acceleration:

$$a = \frac{F-f-mg\sin\theta}{m} = \frac{120-23.5-12*9.8\ sin37°}{12} = 2.144\, m/s^2$$

$$by\ 2ad = V^2 - V_o^2 \quad V_o = 0$$

$$V^2 = 2ad = 2(2.144)(20) = 85.76\, s^2/s^2 \quad V = 9.26\, m/s$$

In charge in k.e is $\Delta ke = \frac{1}{2}mV^2 - \frac{1}{2}mV_o^2 = \frac{1}{2}mV^2$

$$= \frac{1}{2} * 12 * (85.76) = 514.5j$$

c. The altitude of the block after it has moved 20m is

$h = d\sin\theta$

The change in p.e is: $\Delta p.e = mgh - o = mgh$

$= mgd \sin\theta$

$= 12 * 9.8 * 20 \sin 37°$

$= 1415.5j$

19.

a. Assumption of the kinetic theory of gases :

- The number of molecules is large, and the average separation between them is large compared with their dimension
- The molecules undergo elastic collisions, with each other
- The intermolecular forces are negligible except during collision
- Te molecules obey Newton's law of motion but the individual molecules move in random fashion
- The time occupied by a collision is negligible composed with the time spent by a molecule between collision
- Between collisions a molecule moves with uniform velocity
- The volume of the molecules themselves can be neglected compared with the volume occupied by the gas

b. $= \frac{1}{3}\rho C^{-2}$ $\rho = \frac{Nm}{V}$,

Where

Nm=the total mass of gas

N=number of molecules of gas

M=mass of a molecule of gas

$$P = \frac{1}{3}\frac{NmC^{-2}}{V} \qquad PV = \frac{1}{3}\frac{NmC^{-2}}{V}$$

N=n NA

Where n is the number of moles of moles of gas and NA is Avogadro's number

$$PV = \frac{1}{3}nNAmC^{-2}$$

According to the equation of state for an ideal gas, $PV = nRT$

We have $\frac{1}{3}nNAmC^{-2} = nRT \quad or\ \frac{1}{2}mC^{-2} = \frac{3}{2}\frac{R}{NA}T$

The molecular kinetic energy is $\frac{1}{2}mC^{-2} = \frac{3}{2}KT$

Where $K = \frac{R}{NA}$ the Bolt Mann's constant and R is is the universal gas constant

c.

i. $n = \frac{PV}{RT}$ T=27+273=300k

$$N = nNA = NA\frac{PV}{RT}$$

$$N = \frac{(6.023 * 10^{23})(1.0)(50 * (10^{-2})^2)}{(8.314)(300)}$$

$$= 1.21 * 10^{16}\ molecules$$

ii. $\rho = \frac{Nm}{V} \quad m = \frac{\mu}{NA} \quad where\ \mu\ is\ the\ mass\ of\ one\ mole$

$$\rho = \frac{16N}{NAV} = \frac{(2.0 * 10^{-3})(1.21 * 10^{16})}{(6.022 * 10^{23})[50 * (10^2)^3]} = 0.8 * 10^{-6}\ kg/m^3$$

$$C^{-2} = \frac{3P}{\rho}$$

$$the\ rms\ speed\ is\ \sqrt{C^{-2}} = \sqrt{\frac{3p}{\rho}}$$

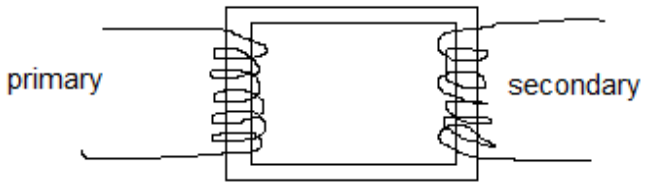
$$\sqrt{C^{-2}} = \sqrt{\frac{3(1.0)}{0.8 * 10^{-6}}} = 1.94 * 10^3\ m/s$$

20.

a.

- In self induction current changing in a coil or circuit can induce an e.m.f in the same coil or circuit.
- In mutual induction, current changing in one coil or circuit (the primary) can induce an e.m.f in a neighbouring coil or circuit (the secondary).

b. A transformer changes i.e transforms an alternating potential difference from one circuit to another using mutual induction principle.



A changing current in the circuit (the primary) creates a changing magnetic field, in turn; this magnetic field induces a changing voltage in the second circuit (the secondary).

c. Causes of inefficiency in a transformer
   i. Resistance of windings or the copper wise used for the windings has resistance and heat losses (RI^2) occur.
   ii. Eddy currents
   The alternating magnetic flux induces eddy currents in the ion core and causes heating.
   iii. Hysteresis

The magnetization of the core is repeatedly reversed by the alternating magnetic field. The resulting expenditure of energy in the core appears as heat.

iv. Flux leakage

The flux due to the primary may not all link the secondary if the core is badly designed or has gaps in it.

d.

$$\frac{\varepsilon_2}{\varepsilon_1} = \frac{N_2}{N_1} \quad \varepsilon_2 = \varepsilon_1 \frac{N_2}{N_1} \quad = 240 \frac{60}{1200} = 12v$$

$$\varepsilon_2 = RI_2 \quad I_2 = \frac{\varepsilon_2}{R} = \frac{12}{3} = 4A$$

SECTION C

21.

a.

- The rms value of an alternating current is the steady direct current which convert electrical

energy to other forms of energy is an ($I_r = \frac{I_o}{m}$) given resistance at the same rate as the A.C

- The pack value of an A.C is the maximum value of an A.C in the positive or negative direction

b. j

i. the impedance of an LRC sens circuit is given by: $Z = \sqrt{R^2 + (LW + \frac{1}{CW})^2}$ And the current is given by:

$$I = \frac{\varepsilon_o}{\sqrt{R^2 + (LW + \frac{1}{CW})^2}}$$

Where ε_o is the P.D applied to the circuit. The current amplitude I vary with the frequency. Its maximum value occurs at which the impedance Z is minimum (i.e Z=R) ($X_L = X_c$)

This peaking of the current amplitude at a certain frequency is called **resonance.**

ii. Application of resonance

In radio receivers and television receivers, the resonant frequency of the circuit is turned (by varying a capacitor) to the frequency of the signal desired to be detected.

c.

i. The band width of a series RLC circuit is the range of frequency for which the power dissipated in the resistance is greater than or equal to the half power dissipated at resonance.

ii. The quality factor or Q =factor is the voltage drop across the inductor (or capacitor) at resonance, divided by the voltage across the resistor.

d. $Q = \frac{V_r}{V_R}(at\ resonance) = \frac{LW_oI}{RI} = \frac{LW_o}{R} = \frac{2\pi f_o l}{R}$

Where $f_o$is the resonance frequency.

e. The power dissipated in the resistance is:

$$P = RI^2 = R(\frac{\varepsilon_o}{Z})^2 = \frac{R\varepsilon_o^2}{Z^2}$$

The power dissipated in the resistance at resonance is:

$$P_{max} = \frac{R\varepsilon_o^2}{R^2} = \frac{\varepsilon_o^2}{R}$$

$$P \geq \frac{1}{2}P_{max}\ \frac{R\varepsilon_o^2}{Z^2} \geq \frac{1}{2}\frac{\varepsilon_o^2}{R} \qquad or\ 2R^2 \geq Z^2$$

The two frequencies f_1 and f_2 at the half power points are determined for$2R^2 = Z^2$

i.e $2R^2 = R^2 + (LW - \frac{1}{CW})^2$

$$R^2 = (LW - \frac{1}{CW})^2 \qquad LW - \frac{1}{CW} = \pm R$$

$$LW - \frac{1}{CW} = -R \qquad LCW^2 + CRW - 1 = 0$$

$$W_1 = 2\pi f_1 = \frac{-CR + \sqrt{C^2R^2 + 4LC}}{2LC}$$

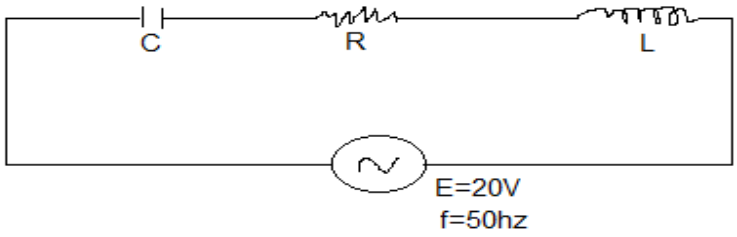
$$LW - \frac{1}{CW} = +R \qquad LCW^2 - CRW - 1 = 0$$

$$W_2 = 2\pi f_2 = \frac{+CR + \sqrt{C^2R^2 + 4LC}}{2LC}$$

$$\Delta w = 2\pi(f_2 - f_1) = 2\pi\Delta f = \frac{R}{L}$$

$$\Delta f = \frac{R}{2\pi L}$$

f.



i.

At resonance Z=R and I=0.50A

$$I = \frac{\varepsilon}{R} \quad R = \frac{\varepsilon}{I} = \frac{20}{0.5} = 40A$$

ii. $f = \frac{1}{2\pi\sqrt{LC}}$

$$L = \frac{1}{4\pi^2 f^2 c} = \frac{1}{(4\pi^2)50^2(1.0 * 10^{-6})} = 10.13H$$

iii. $V_c = \frac{I}{CW} = \frac{1}{2\pi fc} = \frac{0.5}{(2\pi)(50)(1*10^{-6})} = 1591.5v$

22.

a.

i. The thermo ionic emission is the process by which an electron is liberated from the surface of a metal heated.

ii. Cathode rays are streams of electrons moving at high speed in a tube highly evacuated.

b. Properties of cathode rays:

- They travel from cathode in straight lines

- They cause certain substance to fluorescence
- They can be deflected by a magnetic field
- They can be deflected by an electric field
- They produce X-rays on striking matter
- They possess kinetic energy

c. The main parts of a cathode-ray oscilloscope are:

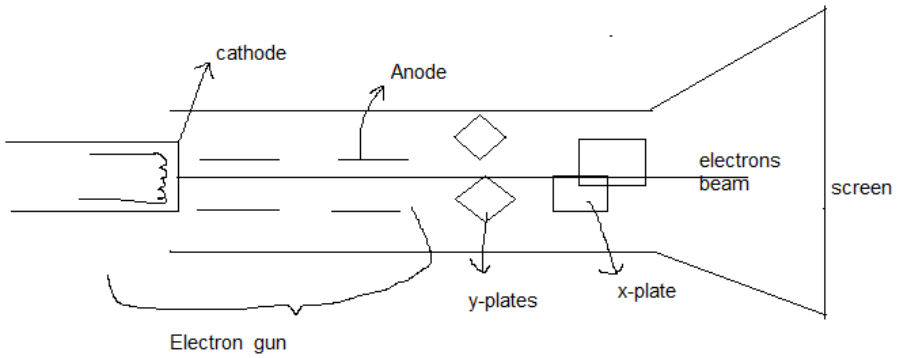
- Electric gun

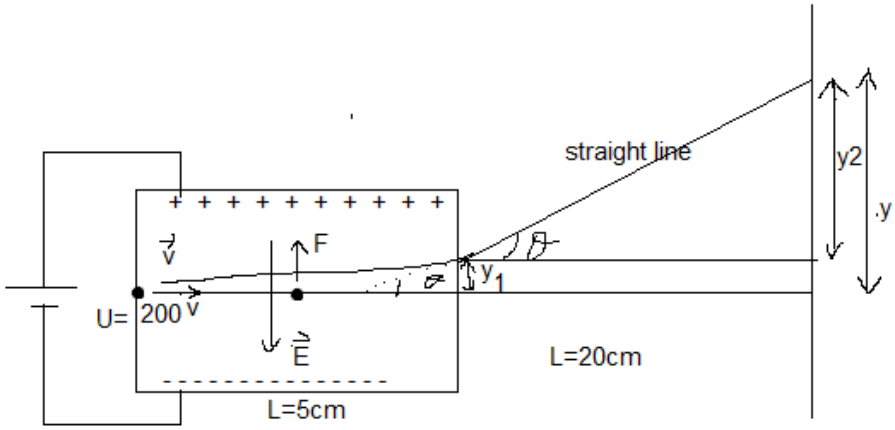
  This is an electrode assembly for producing a narrow beam of cathode rays. The gun comprises an indirectly heated cathode, the grid and anodes. The grid has a negative potential with respect to the cathode and controls the number of electrons reaching the anodes from the cathode.

  The anodes accelerate the electrons to a high speed down the tube and their shape and potential are such that the electric fields between them focus the beam to a spot on the fluorescent screen.
- Deflecting system

  The beam from anodes possess first between a pair of horizontal metal plates (the y-plates) that cause horizontal deflection and then between vertical plates (the x-plates) that cause horizontal deflection when a P.D is applied to them.
- Fluorescent screen

  The inside of the wide end of the tube is cooled with a phosphor which emits light when struck by fast-moving particles.





K.E of the electron is $ke = \frac{1}{2}mV_o^2 = 10kev = 1.6 * 10^{-15}j$

Inside the plates, the electric field is constant and is given by:

$$E = \frac{U}{d}$$

The force acting on the electron $F = -eE$, perpendicular to the direction of the initial velocity V_o.

The acceleration of the electron $a = \frac{F}{m} = \frac{-eE}{m}$ and directed along y-axis: its magnitude is:

$$a = \frac{-eE}{m} = \frac{eU}{md}$$

The components of velocity of the electron after it has been in the electric field are given by:

$$V_x = V_o = constant\ V_y = at = \frac{eU}{md}t$$

The coordinates of the electron between the plates is a parabola. The electron continues is a straight line after leaving the field. The deflection at the end of the plates (x=e) is

$$y_1 = \frac{eUl^2}{2mV_o^2 d}$$

$$\tan\theta = \frac{dy}{dx} = \frac{eU}{mV_o^2 d} \quad x = l$$

$$y_2 = L\ tan\theta = \frac{eULl}{mV_o^2 d}$$

The total deflection of the electron on the screen is

$$y = y_1 + y_2 = \frac{eUl}{mV_o^2 d}\left(L + \frac{l}{2}\right) = \frac{eUl}{m\ ke\ d}\left(L + \frac{l}{2}\right)$$

$$y = \frac{1.6 * 10^{-19} * 200 * 0.05}{2 * (1.6 * 10^{-15})(0.02)}\left(0.20 + \frac{0.05}{2}\right)$$

$$= 5.625mm$$

PHYSICS 2009

SECTION A

1.
   a. A fibre optic cable is a set of bundles of glass or of plastic, capable of transmitting messages modulate into light waves. Or a fibre optic cable is a light pipe which is used to transmit information from one point to another by using the principle of total internal reflection of light.
   b.
      - Fibre optic can carry much more information i a smaller cable.
      - Fibre optics are easy manufacture
      - Fibre optics can transmit information in form of pictures
2.
   a.
      - Hypermetropia, when we have the image of an object is behind the retince
      - Myopia; the image of an object is formed in front of the retine
   b.
      - Hypermetropia is corrected by using a converging lens spectale
      - Myopia is corrected by using diverging lens spectavles
3. K
   - Avantages of wind energie:
      - The wind is free
      - It doesn't cause environmental pollution
      - Wind turbines are available in a range of size
      - It is suitable for decentralised system
   - Disavantage of wind energie:
      - The supply of wind is infinite through variations occur depending time aand seasons.

- The force of wind is not constant it varies from zero to strong force. This means that wind turbines don't produce the same amount of electricity all the time
- Wind turbines are noisy
- It needs constant monitoring by technical people.

4. The distance travelled by the first particle:

$$d_1 = 90m - 30m = 60m$$

The distance travelled by the second particle:

$$d_2 = 30m$$

For the first particle (moving down), we have the initial velocity $u = 0$ and $d_1 = \frac{1}{2}gt^2$

$$t = \sqrt{\frac{2d_1}{g}} = \sqrt{\frac{2(60)}{9.8}} = 3.49sec$$

For the second particle (moving up):

$$d_2 = ut - \frac{1}{2}gt^2 \qquad u = \frac{2d_2 - gt^2}{2t}$$

The time is the same:

$$u = \frac{2(30) + 9.8(3.49)^2}{2(3.49)} = 25.78\,m/s$$

5. Advantage of friction:
   - Walking: you could not walk without friction between your shoes and ground. As you try to step forward, you push your foot backward, friction holds your shoes on ground, allow you to walk.
   - Writing: writing with a penal requires friction you could not hold in your hand without friction.
   - Driving car: your car would not start moving if it was not for friction, the tyres would just spin. You would not also stop without the friction of the brakes and the tyres.
   - Static electricity: when two different bodies are rubbed together, they acquire opposite's charges which is static electricity.

Disadvantages of friction:

- Wastage of energy: in moving parts of machine, if they are not lubricated well, friction will cause more energy to be expended, and, in pushing and pulling an object friction wastes energy.
- Friction heats parts: the law of conservation of energy remains constant. This the energy that is "lost" to friction in trying to move an object is really tuned to heat energy, the friction of parts rubbing together crates heat which may result into fire hazard.
- Wear: friction force between two moving parts of a machine cause them to wear out and get old father
- Unwanted noise: friction force between 2 moving parts of machine cause noise pollution.

6.

a. The principle of equilibrium state that, a body which is subjected to coplanar forces will be in equilibrium if:
   - The algebraic sum of all the alternal forces is zero
   - The algebraic sum of moments of all the external force about any point in their plane is zero.

b. The resultant force on X-axis is:

$$F_x = 2.83\sin 45 - 4\cos 60 + 6\cos 30 = 5.2N$$

The resultant force on y-axis is:

$$F_y = 2.83\cos 45 - 4\sin 60 + 6\sin 30 = -4.46N$$

The magnitude of the resultant force is:

$$F = \sqrt{F_x^2 + F_y^2} = 6.85N$$

Direction $tg\theta = \frac{F_x}{F_y} = \frac{-4.46}{5.2} = -40.6°$

The resultant force makes an angle of 40.6° with x-axis and 49.4 withy y-axis.

7.

a. Surface tension is the for per unit length acting in the surface perpendicular A_o one side of a line in the surface.

$$D = \frac{F}{l}$$

Surface tension is energy per unit surface
Surface tension is what causes the surface of a portion of a liquid to be attracted to another surface.

b.

- Walking on water: small insects can walk water because their weight is not enough to penetrate the surface because the surface of a liquid behaves like a perfectly elastic membrane. This is due to strong cohesive forces between the water molecules.
- Floating a needle: if carefully placed on the surface a small needle can be made to float on the surface of water even though it is several time as dense as water.
- Soaps and detergent: help the cleaning of clothes by levering the surface tension of the water so that it ready cut into pures and soldes areas
- Surface tension disinfectants'; disinfectant are usually solution of low surface tension. This allows them to spread out on the cells walls of bacteria and descript them.
- Capillarity: when a tube of small diameter is putted, immersed in water, the water rises up the tube; this is due on the tension cohesive forces and the forces of adhesion between the water molecules and the capillary walls.
- Bubbles and drops: when water is dripping from the top it came out as spherical droops, this is because the force of cohesion are greater than the force of adhesion.

8. A

a. Coherent sources' are those sources of constant phase difference i.e the same frequency, amplitude and wavelength or zero phase difference
b. The two sources should emit continuously move of same wavelength and frequency

9. Light is a particular because:
   - It forms sharp shadows reflection and photo electric effect
   - Refraction of light which change its direction
   - It content photons light is a wave because
   - It can be interfere can be diffracted
   - It possesses frequency
   - Light beams travels at the same speed in the same medium

10.
a. The sound is the sensation caused by the compressions and refraction of material medium.
b. $V = V_o\sqrt{\frac{T}{T_o}}$ $\frac{V}{V_o} = 1.5$ $and\ T_o = 273°k$

$$\frac{V}{V_o} = \sqrt{\frac{T}{T_o}} \qquad 1.5 = \sqrt{\frac{T}{273}} \quad T = 614.2°k$$

11.
a. We know that:

$$Fel = \frac{e^2}{4\pi\varepsilon_o r^2} \quad and \quad F_{cp} = m\frac{V^2}{r}$$

$$Fel = F_{cp}$$

$$\frac{e^2}{4\pi\varepsilon_o r^2} = m\frac{V^2}{r}$$

$$V^2 = \frac{e^2}{4\pi\varepsilon_o mr} \quad Ke = \frac{1}{2}mV^2 \quad ke = \frac{e^2}{8\pi\varepsilon_o r}$$

b. $Pe = \frac{-e^2}{4\pi\varepsilon_o r}$

The total energy

$$E = ke + Pe = \frac{e^2}{8\pi\varepsilon_o r} - \frac{-e^2}{4\pi\varepsilon_o r} \qquad E = \frac{-e^2}{8\pi\varepsilon_o r}$$

12.

a. X-radiation is a form of electromagnetic radiation. X-ray have a wavelength in range of 10 to 0.01 manometers corresponding to the frequencies in the range of $30\ 10^{15}Hz\ \ to\ 30\ 10^{18}Hz$

b. Hard x-rays are highest energy x-rays soft x-rays are lowest energy x-rays. Hard x-rays are produced when electron hit a heavy target such as lead and potassium. Soft x-rays are produced when electrons hit a soft light target such as aluminium.

c.

- The precaution is to use a lend shield because x-rays cannot penetrate through it.
- To avoid unnecessary exposure always when operating the x-rays machine. The x-rays should be directed at the exact part under examination.

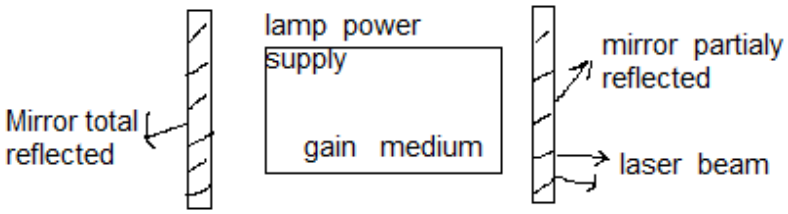
13.

a. The photoelectric effects is a phenomenon in which electrons are emitted from matter after the absorption of energy form electromagnetic radiation such as x-rays or visible light.

b. $hf = \varphi + Ke_{mx}$ Einstein's equation
Energy of photon=energy needed to remove an electron + kinetic energy of the electron emitted.
$\varphi = hf_o$ =The work function i.e the minimum energy required to remove an electron from the surface of any given metal.
f_o= the threshold frequency for the photo electric effect to occur
$Ke_{mx} = \frac{1}{2}mV_{mx}^2$=the maximum kinetic energy of emitted electron
V_{mx}: The speed of the ejected electron
f: The frequency of the incident photon

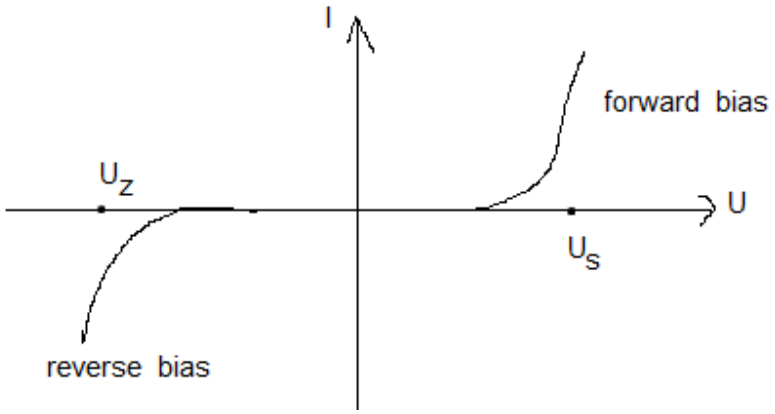
14.

a. A LASER is a device emits light through a process called stimulated emission. The term laser is an acronym for"light amplification by stimulated emission of radiation."
b. Principal components of a laser



15.

a. A Zener diode is a semiconductor device which works as voltage regulator in electronic circuit. It conducts in the reverse direction at a certain fixed voltage. A typical characteristic I/V of a Zener diode is shown in fig below:



b. Zener break down occur in heaving doped P-n function, the heavily doping makes the depletion lager-extremely thin. When the electric field across P-n function is too strong that it can directly tear out a bound electron from covalent band, there by generating a large number of electron hole pairs and thus increasing the reverse current. Zener voltage is the value of reverse voltage at which break down occurs.

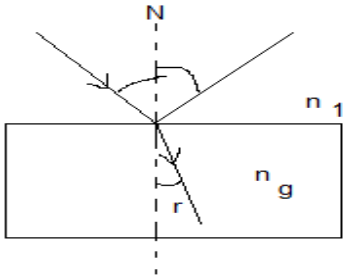
SECTION B

16.

a. Refraction is the change of direction of wave due to a change in its speed. Refraction index is defined as the speed of the wave in vacuum divided by the speed of wave in the medium.

b.

i.



$$n_1 \sin\alpha = ng \sin r \qquad r + \alpha + 90 = 180 \qquad r + \alpha = 90$$

$$n_1 \sin\alpha = ng \sin(90 - \alpha) \qquad ng = n_1 tg\alpha$$

ii. $ng = n\, tg(\alpha + 8) with \quad n_r = 1$

$$= \frac{\tan\alpha + \tan 8}{1 - \tan\alpha \tan 8} \qquad with \quad \tan\alpha = \frac{ng}{n_1}$$

$$ng = \frac{\frac{ng}{n_1} + \tan 8}{1 - \frac{ng}{n_1}\tan 8} \qquad ng = \frac{ng + n_1 \tan 8}{n_1 - ng \tan 8}$$

$$ng^2 \tan 8 + (1 - ng)\tan 8 + n_1 \tan 8 = 0$$

$$\Delta = 0.003821$$

$$ng = \frac{033 \pm 0.062}{2\tan 8}, \quad ng_1 = 1.39 \; or \; ng_2 = 0.95 < 1 \not\in$$

$$\tan\alpha = \frac{ng}{n_1} = \frac{1.39}{1.33} \quad \alpha = 46.3 \text{ and } ng = n_1 \tan\alpha$$

$$ng = \frac{\tan\alpha + \tan 8}{1 - \tan\alpha \tan 8}$$

$$n_1 \tan\alpha - n_1 \tan 8 \, tan^2\alpha - \tan\alpha - \tan 8 = 0$$

$$n_1 \tan 8 tan^2\alpha + (1 - n_1)\tan\alpha + \tan 8 = 0$$

$$0.187 \, tan^2\alpha - 0.333 \tan\alpha + 0.141 = 0$$

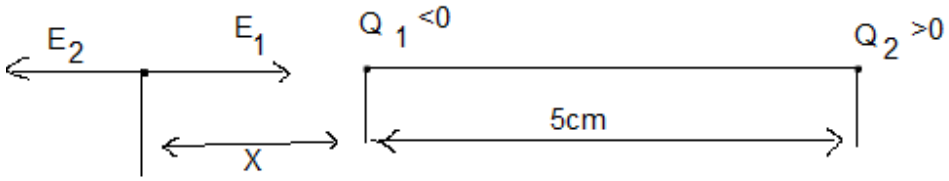
$$\Delta = 0.006 \; \tan\alpha = \frac{0.333 \pm 0.074}{0.374}, \tan\alpha = 0.693 \; and \; ng = 0.9 \not\in$$

$$\tan\alpha = 0.693 \quad and \quad ng = 1.45 \quad \alpha = 47.42°$$

17.

a. The electric force exerted between two points φ_1 and φ_2 is directly proportional to the product of the magnitude of the charge and inversely proportional to the square of the square of the separation between the charges.

b.



$$E_1 + E_2 = 0 \quad E_1 = E_2 \quad \frac{kq_1}{x^2} = \frac{kq_2}{(x+5)^2}$$

$$\frac{q_1}{x^2} = \frac{q_2}{(x+5)^2} \quad \frac{3}{x^2} = \frac{7}{(x+5)^2}$$

$$4x^2 - 30x - 75 = 0 \quad \Delta = 0.21$$

$$x_1 = -0.019m \not\in \quad x_2 = 0.09475m$$

18.

a. An artificial satellite of the Earth's any object made by man which moves round the earth in orbit, while a natural satellite of the Earth is any natural object revolving about Earth.
b. Artificial satellite can be used in:
    1) Telecommunication: television programmes and telephone conversations can be transmitted from country by being bounced of satellites.
    2) Weather forecasting: rain clouds, can be tracked using the pictures, there satellite send back to earths
    3) Military: countries can rise spy satellites, to find out if another country is carrying out secret military manoeuvres
    4) Mapping: satellites are used in drawing geographical maps (geological, metrological...)
    5) Space observation: artificial satellite are used to study the universe galaxies.

c.
    i. Geostationary satellite is a satellite which appears to be at a fixed position at a definite height
    ii. Law earth orbit is an orbit round the earth at low altitude.

d. If the satellite is moving by a velocity and revolves round the Earth at a height above its surface, the required centripetal force will be:

$$F_{cp} = \frac{mV^2}{R+h} \quad also\ F_G = \frac{G\ M_T m}{(R+h)^2}$$

$$F_{cp} = F_G \quad \frac{mV^2}{R+h} = \frac{G\ M_T m}{(R+h)^2}$$

$$V^2 = \frac{G\ M_T}{R+h}$$

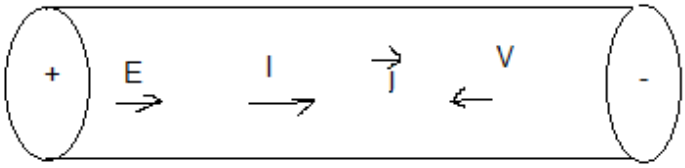
If g is the acceleration due to gravity at the earth's surface:

$$\frac{G\ M_T m}{R^2} = mg$$

$$g = \frac{G\,M_T}{R^2}$$

$G\,M_T = gR^2$ then $V = R\sqrt{\frac{g}{R+h}} = 6.4\,10^6\sqrt{\frac{9.8}{6.4\,10^6+35.7\,10^3}} = 3085\,m/s$

19.



a. E: electric field
   I: intensity of current
   J: density of current
   V: velocity of charges

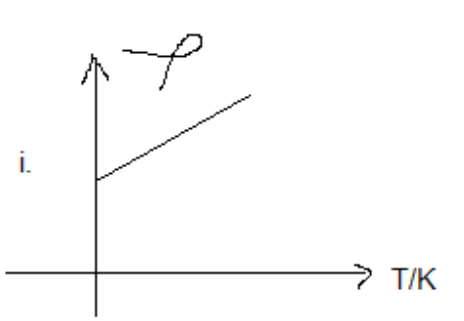
b. $E = \frac{V}{l} = \frac{10}{10^3} = 10^{-2}\,v/m$

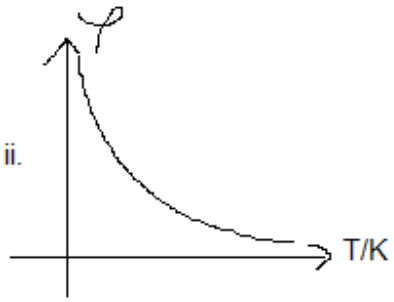
c. $j = G.E = \frac{E}{\rho} = \frac{10^{-2}}{1.75\,10^{-8}} = 5.75\,10^5\,A/m^2$

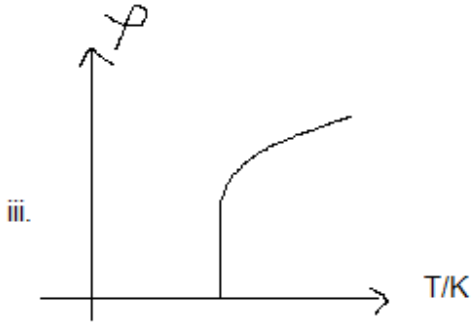
$$I = JA = 5.75\,10^5 * 10^6 = 0.571A$$

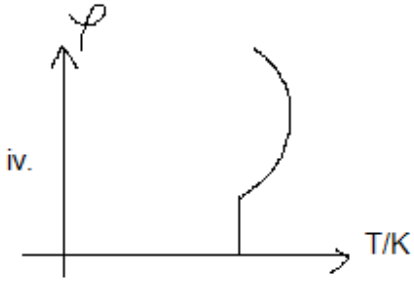
d. $R = \frac{V}{I} = \frac{10}{0.571} = 17.5\Omega$

e.









20.

a. Height voltages are needed in order to minimize $I^2R = P_o$ power losses in transmission, power supplied $P = I - V \;\; I = \frac{P}{V}$

   If we introduce I in expression of power losses we find $P_o = (\frac{P}{V})^2 R$

   Hence from the above expression, P_o decrease, if V is increased.

b. Advantage of ac avec d.c, power transmission

   - Easy change of voltage with transformer, alternating voltage can be stopped up or down in amplitude according to the use. At the electric power station, the transformer output power at high voltage and low current level. At the consumer end of the transmission lines, the voltage is stepped down the value required by the load.

- In alternating current the I^2R power losses are minimal than in direct current. This is because the current in ac system can be minimized, which is not the case with direct current.

c.

i. $\frac{V_p}{V_s} = \frac{n_p}{n_s}$ $\frac{n_p}{n_s} = \frac{240}{9} = 26.67$

$$\frac{V_p}{V_s} = \frac{I_p}{I_s} = \frac{n_p}{n_s}$$

ii. Re effective potential at secondary is:

$$V_s = \frac{V_{mx}}{\sqrt{2}} = \frac{9}{\sqrt{2}} = 6.36V$$

$I_s = \frac{V_s}{R} = \frac{6.36}{5} = 1.27A$

iii. $P_m = V_s I_s = 6.36 * 1.27 = 8W$

PHYSICS 2010

SECTION A

1.

a. A telescope is an optical instrument used to observe object considered to be at infinity using electromagnetic radiations.

b.

- It is used to detect electromagnetic radiations (ex: radio waves) for analysis
- It is used for observation ex: in a spectrometer
- It is used to observe object which are far ex: for observation of stars

2.

a. The potential energy increases because when a spring is compress a work is done also the potential energy is proportional to the square of the compressed distance, and then it will increase. $Pe = \frac{1}{2}kx^2$
b. The potential energy increase, because when a spring is stretched, a work is done, also the potential energy will increase because it is proportional to the square of the stretch distance. $Pe = \frac{1}{2}kx^2$
c. The potential energy decreases because two charges of opposite signs attract.
d. The potential energy increases because a work will be done to move the object away the gravitational field. Or $Pe = mgh$ and h will increases
e. The potential energy will decreases because the drop is pushed by the upward force (Archimedes's principle)

3. The trajectory or particles must be a circumference and the distance between the two particles is the diameter d of the circle. Each particle will return to its initial position after a time $t = \frac{\pi d}{V}$
4. Condition of equilibrium:

$$F_1 + F_2 + F_3 = 0$$
$$F_3 = -(F_1 + F_2)$$

$F_3 = -R \quad where\ R = F_1 + F_2$

5. $Q = mc\Delta t$

$$Q_c = Q_r$$
$$m_1 c(90 - t) = m_2 c(t - 10)$$
$$m_1\ 90 - m_1 t = m_2 t - m_2\ 10$$
$$t = \frac{m_1\ 90 + m_2\ 10}{m_1 + m_2} = \frac{90 * 1.5 + 10 * 10}{1.5 + 10} = 20.4°c$$

6.
a. Is the rise of a liquid in a fine bore (capillary) tube caused by the surface tension
b.

- In the leaf of a true we have capillary tube for conducting water
- In oil lamp or Kerosene lamp, the oil or kerosene moves up by capillary action
- The water is take away the human body by a hand towel using the capillary action
- Water becomes cold in period of drought in a slit by capillary action

7.

a. The period of a simple pendulum is inversely proportional to the square root of the acceleration due to gravity. When a pendulum is at a mountain its acceleration due to gravity decreases and its period increases. Then, the pendulum will loss time

$$T = 2\pi\sqrt{\frac{l}{g}}$$

b. To avoid resonance phenomenon. If the frequency of solders is equal to the frequency of oscillations of the bridge, the bridge will vibrate by a maximum and it will be destroy.

8.

a.

- An anode it's a point which vibrate by a zero amplitude (maximum pressure)
- An antinodes' a point which vibrates by a maximum amplitude (minimum pressure)

b. No

c. The distance is $\lambda/4$

d. $\varphi = \frac{2\pi}{\lambda}x = \frac{2\pi\lambda/10}{\lambda} = \lambda/4\, rad$

9. $\lambda = \frac{V}{f} = \frac{332}{10^3} = 0.332m$

$$x = d_1 - d_2 = 83cm = 0.83m$$
$$\lambda/_2 = 0.332/_2 = 0.166m$$
$$\frac{d_1 - d_2}{\lambda/_2} = \frac{0.83}{0.166} = 5$$

Then $d_1 - d_2 = 5\,\lambda/_2$

We have a destructive interference because $d_1 - d_2$ is a multiple impair of $\lambda/_2$

10.

a. $E = hf = qu$

$$\lambda = \frac{hc}{qu}$$
$$\lambda = 3.1\ 10^{-10}m$$

b. We have the same result, the effect

c. The beams of electrons are easily produced and accelerate than beam of protons.

11.

a. $f = \frac{c}{\lambda} = \frac{3\ 10^8}{505\ 10^{-9}} = 5.941\ 10^{14}Hz$

b. $E = hf = 6.63\ 10^{-3} * 5.94\ 10^{14} = 3.94\ 10^{-19}j = 2.46ev$

c. $Ke = \frac{1}{2}mV^2 \quad V = \sqrt{\frac{2ke}{m}} = 9.1\ 10^{-3}\,m/s$

12.

a. The magnetic flux in a coil is given by $\varphi = NBS$

$S = \pi r^2 = \pi(00.04)^2 = 0.005m^2$

The e.m.f induced is $e = \frac{-d\varphi}{dt} = \frac{-d(NBS)}{dt} = -NS\frac{dB}{dt}$

$$e = -NS\frac{d(0.012t + 3\ 10^{-5}t^4)}{dt}$$
$$= -500 * 0.005\ (0.012 + 1210^{-5}t^3)$$

$$e = -(0.03 + 3\ 10^{-4}t^3)\ \ in\ volts$$

b. $t = 5sec$

$$e = -[0.03 + 3\ 10^{-4}(5^3)] = -0.0675v$$

$$I = \frac{|e|}{R} = \frac{0.0675}{600} = 1.125\ 10^{-4}A$$

13.

a. It is a process where matter is decomposes in a medium where we haven't oxygen.

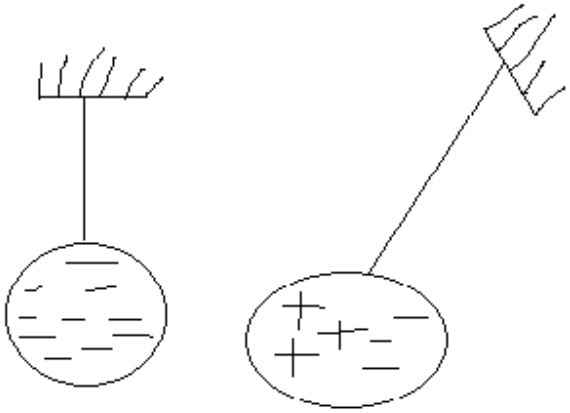
b.

i. Biogas it's a gas which result of fermentation of organic material from which bio fuels (e.g methane gas) can be obtained by processing. It is use to produce electricity, in cooking using heat

ii. Digester: it is a vat using to transform organic material into a biogas

14.

a. We will observe an attraction due to the electrisation by induction



b. We will observe repulsion, because after contact the two spheres will have the same charge.

15.

a. $I = \frac{U}{Z}$ or $z = \sqrt{R^2 + L^2W^2} = \sqrt{(0.4)^2 + (250)^2(200)^2} = 224\Omega$

$$I = \frac{30}{224} = 0.314A$$

b.

$$\tan\rho = \frac{LW}{R} \quad \varphi = 26.565°$$

The potential lead the current.

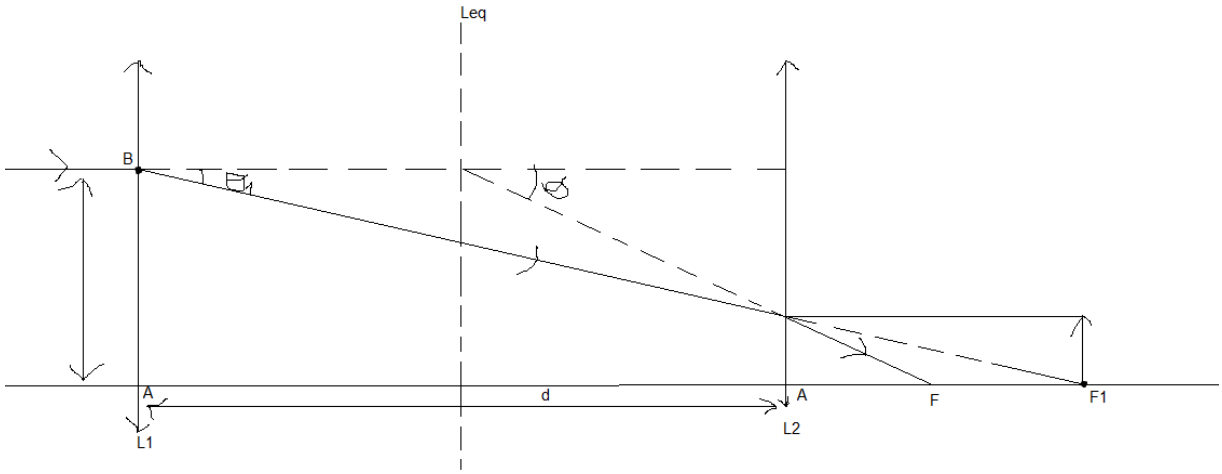
SECTION B

16.

a.

- Is the inverse of the focal distance $P = \frac{1}{f}$
- The power of a lens is its capacity to be more converging or more diverging
- Is dioptre(D) or m^{-1} or rad/m

b. It is a lens which can replace two or (many lens) by producing the same deviation



$$\theta = \frac{h_1}{f} \quad \theta_1 = \frac{h_1}{f_1} \quad and\ \theta_2 = \frac{h_2}{f_2}$$

$$\theta = \theta_1 + \theta_2$$

$$\frac{h_1}{f} = \frac{h_1}{f_1} + \frac{h_2}{f_2}(1)$$

In the triangle ABF$_1$ and A'B'F

$$\frac{h_1}{f_1} = \frac{h_2}{AF_1} \quad or\ A'^{F_1} = f_1 - d$$

$$\frac{h_1}{f_1} = \frac{h_2}{f_1 - d} \quad or \quad h_2 = \frac{h_1(f_1 - d)}{f_1}(2)$$

Putting h_2 in (1):

$$\frac{h_1}{f} = \frac{h_1}{f_1} + \frac{h_1(f_1 - d)}{f_1 f_2}$$

$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} - \frac{d}{f_1 f_2}$$

17.

a.

- Elastic collision it's a collision where we have conservation of momentum and kinetic energy (no loss of kinetic energy)
- Inelastic collision it's a collision where we have only conservation of momentum no conservation of kinetic energy.

b. Before collision After collision

#

Momentum before: $P = m_1U_1 + m_2U_2$

Momentum after: $P' = m_1V_1 + m_2V_2$

$$P = P'$$
$$m_1V_1 + m_2V_2 = m_1U_1 + m_2U_2(*)$$
$$m_2(U_2 - V_2) = m_1(U_1 - V_1)(1)$$

Conservation of kinetic energy:

$$\frac{1}{2}m_1U_1^2 + \frac{1}{2}m_2U_2^2 = \frac{1}{2}m_1V_1^2 + \frac{1}{2}m_2V_2^2$$
$$m_2(V_2^2 - U_2^2) = m_1(U_1^2 - V_1^2)(2)$$
$$\frac{2}{1}: \quad \frac{m_2(V_2^2 - U_2^2)}{m_2(U_2 - V_2)} = \frac{m_1(U_1^2 - V_1^2)}{m_1(U_1 - V_1)}$$
$$V_2 + U_2 = U_1 + V_1$$
$$V_2 = U_1 - U_2 + V_1(3)$$

(3) In (*):

$$m_1V_1 + m_2(U_1 - U_2 + V_1) = m_1U_1 + m_2U_2$$
$$m_1V_1 + m_2U_1 + m_2V_1 - m_2U_2 = m_1U_1 + m_2U_2$$
$$(m_1 + m_2)V_1 = (m_1 - m_2)U_1 + 2m_2U_2$$
$$V_1 = \frac{(m_1 - m_2)U_1}{m_1 + m_2} + \frac{2m_2}{m_1 + m_2}U_2(4)$$

(4) In (3)

$V_2 + U_2 = U_1 + V_1 \quad V_2 = U_1 - U_2 + V_1$

$$V_2 = U_1\left(1 + \frac{m_1 - m_2}{m_1 + m_2}\right) + U_2\left(\frac{2m_2}{m_1 + m_2} - 1\right)$$
$$V_2 = U_1\left(\frac{m_1 + m_2 + m_1 - m_2}{m_1 + m_2}\right) + U_2\left(\frac{2m_2 - m_1 - m_2}{m_1 + m_2}\right)$$
$$V_2 = \frac{2m_1U_1}{m_1 + m_2} + \frac{m_2 - m_1}{m_1 + m_2}U_2$$

c. $m_1 = 0.1kg \quad U_2 = 0 \quad V_1 = \frac{-U_1}{3}$

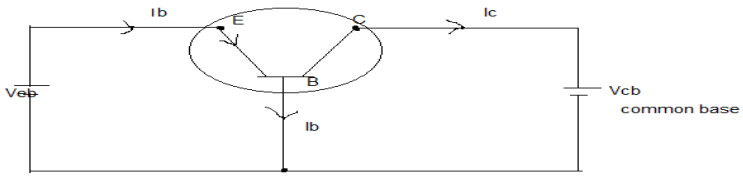
$$V_1 = \frac{2m_2U_2}{m_1 + m_2} + \frac{m_1 - m_2}{m_1 + m_2}U_1$$
$$\frac{-U_1}{3} = \frac{m_1 - m_2}{m_1 + m_2}U_1$$
$$2m_2 = 4m_1 \quad m_2 = 2m_1$$
$$m_2 = 2 * 0.1 = 0.2kg$$

18.

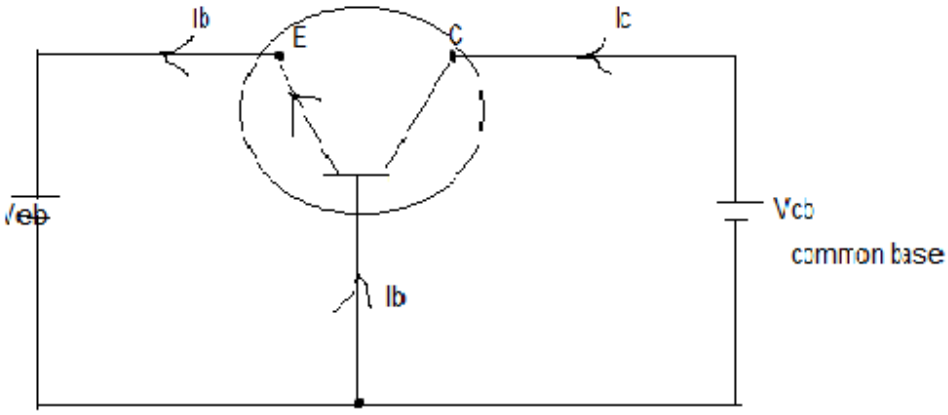
a. It is an electronic component made from three lager of P- and n semiconductors.

b.

i. PNP



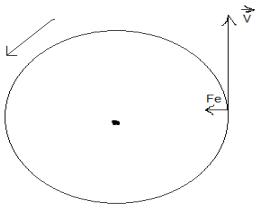
ii. NPN



	I_E	I_B	I_C	V_{EB}	V_{CE}	V_{CB}
PNP	+	-	-	+	-	-
NPN	-	+	+	-	+	+

19.

a.



b. Electric force is given by:

$$Fe = \frac{e^2}{4\pi\varepsilon_o r_n^2}$$

The centripetal force is given by:

$$F_c = m\frac{V^2}{r}$$

$$or\ Fe = Fc \quad \frac{e^2}{4\pi\varepsilon_o r_n^2} = m\frac{V^2}{r} \qquad \frac{e^2}{4\pi\varepsilon_o r} = mV^2$$

$$\frac{e^2}{4\pi\varepsilon_o r} = m\left(\frac{e^2}{4\pi\varepsilon_o nh}\right)^2 \qquad \frac{e^2}{4\pi\varepsilon_o r} = \frac{me^4}{4\pi^2\varepsilon_o^2 n^2 h^2}$$

$$\frac{1}{\pi r} = \frac{me^2}{\varepsilon_o^2 n^2 h^2} \quad r = \frac{\varepsilon_o^2 n^2 h^2}{\pi me^2}$$

c. $T = \frac{2\pi r}{V} = \frac{2\pi(\frac{\varepsilon_o^2 n^2 h^2}{\pi me^2})}{\frac{e^2}{2\varepsilon_o nh}} \qquad T = (\frac{4\varepsilon_o^2 h^3}{me^4})n^3$

For $n = 1\ T_1 = 1.531\ 10^{-6} sec$

$$T_n = n^3 T_1$$

For $n = 2 \quad T_2 = 2^3 T_1 = 12.24\ 10^{-16} sec$

For $n = 3 \quad T_3 = 3^3 T_1 = 41.3\ 10^{-16} sec$

d. The number of orbit $= \frac{t}{T} \quad n = \frac{1\ 10^{-8}}{12.24\ 10^{-16}} = 8.16\ 10^6 cycles$

20.

a.

- The first law refers to any function in the network; it states that the total current flowing into the function is equal to the total current flowing out of it.
- The second law connects the e.m.f and pd. It refers to any closed loop. It states that, round such as loop, the algebraic sum of e.m.f is equal to the algebraic sum of all the pd in that circuit.

b.

i.

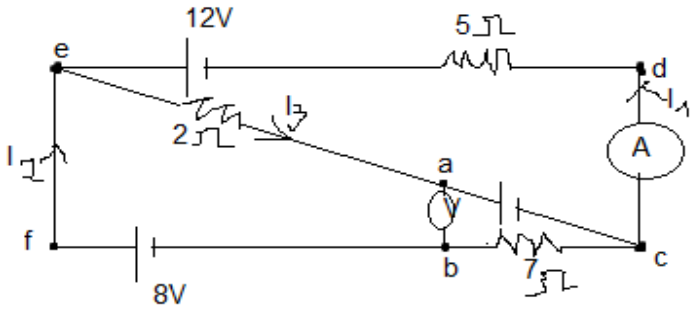
- If a maille passé ina generator from $-$ to $+$ the e.m.f is considers positive.
- If a maille passé in a generator from $+$ to – the e.m.f is considers negative

ii.

- If the maille have the same direction to the current in a resistance RI is positive
- If a maille have an opposite direction to the current in a resistance RI is considers negative

c.

i.



In the maille cdefc

$$-5I_1 + 12 - 8 - 7I_2 = 0$$
$$5I_1 + 7I_2 = 4(1)$$

In the maille cdeac

$$-5I_1 + 12 + 2I_3 + 20 = 0$$
$$5I_1 - 2I_3 = 32(2)$$
$$I_1 + I_2 = I_3(3)$$

(3) in (2): $5I_1 - 2(I_1 + I_2) = 32 \quad 7I_1 - 2I_2 = 32$

$$I_2 = \frac{7I_1 - 32}{2}\ (4)$$

(2)in (1): $5I_1 + 7\left(\frac{7I_1-32}{2}\right) = 4$

$$I_1 = \frac{232}{59} = 3.93A$$

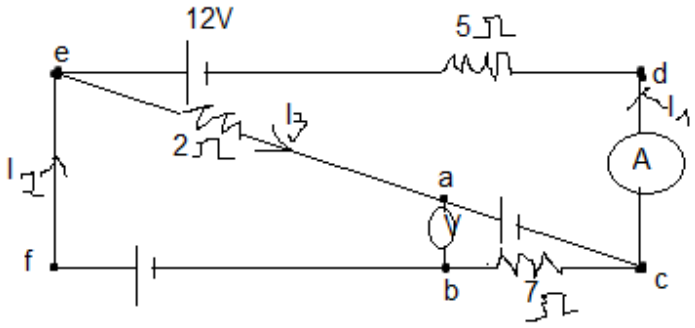
The value indicate by the ammeter is $3.93A$

$$I_2 = \frac{7I_1 - 32}{2} = \ I_2 = \frac{7 * 3.93 - 32}{2} = 2.24A$$
$$I_3 = I_2 - \ I_1 = -2.24 - 3.93 = -6.17A$$

Maille abca:

$$V_{ab} - 7I_2 - 20 = 0 \quad V_{ab} = 7I_2 + 20$$
$$V_{ab} = 7(-2.24) + 20 = 4.32v$$

ii.



PHYSICS 2011

SECTION A

1. The mean density $\sigma = \frac{mass}{volume}$

   Its dimensions ML^{-3}

   The gravitational constant $G = \frac{F\,d^2}{m*m}$

   Its dimensions $M^{-1}L^3T^{-2}$

   The dimensions of P are $\frac{1}{(ML^3M^{-1}T_1^{-2})^{\frac{1}{2}}} = \frac{1}{T^{-1}} = T$

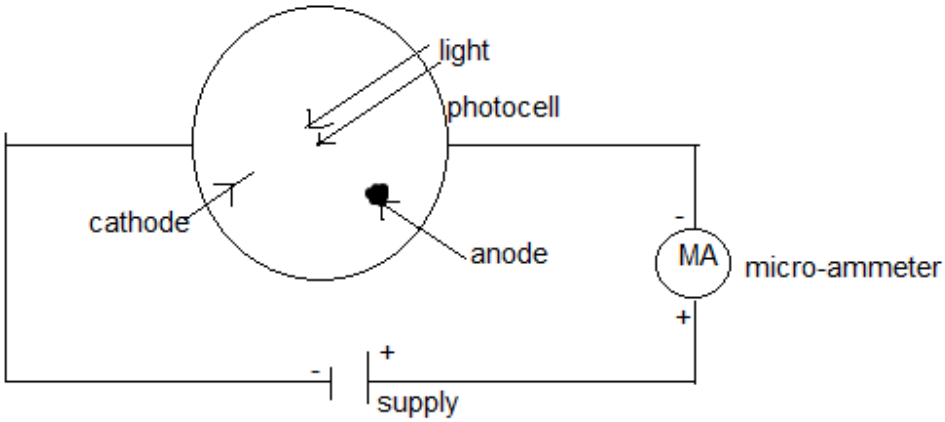
T is the dimensions at time, then the relation is dimensionally correct

2. The critical angle C

$$1.5 \sin c = 1.3 \sin 90$$
$$\sin c = \frac{1.3}{1.5}$$
$$c = 60°$$

3.

   a.



a. If the supply is connected wrong way round, the electric field created by the battery in the direction from cathode towards anode *decelerates.* The emitted electrons by suitable light and the *current does not flow* through the circuit. Or the voltage established will be negative (stopping potential) and the *current will not flow*

4.

- They are much maller and lighter
- They are safer
- They are more economical
- They operate from low voltages
- They operate cold and use much less energy
- Etc

5.

a. The capacitance of a conductor is the *electric charge* required to cause unit *change in the potential* of a conductor.
Or: it is the property of a conductor or system of conductors that describes its ability to store electric charges
Or:$C = \frac{Q}{V}$ Q:charge, V: voltage or p.d

b. $C = \frac{\varepsilon_r \varepsilon_o A}{d}$ $A = \frac{250*10^{-9}*0.1*10^{-3}}{7*8.85*10^{-12}} = 0.40m^2$

6.

a. When two waves travel through a medium the *resultant displacement* at any point is the sum of the *separate displacements* due to the waves.

b.

i. $\lambda = \frac{V}{f} = \frac{340}{340} = 1m$

ii. Wave function

$$y_1 = A\sin 2\pi ft$$
$$y_2 = A\sin 2\pi ft$$
$$y = y_1 + y_2$$
$$y = 2A\sin 2\pi ft$$
$$A_1 = 2A = 2 * 4 * 10^{-6}m = 8 * 10^{-6}m$$

7.

a. The angular momentum about an axis of a given rotating body or system d bodies is *constant if no external torque* acts about that axis.

b.

i. $\alpha = \frac{Z}{I} = \frac{200}{100} rad/s^2 = 2\,rad/s^2$

ii. $w = \alpha t = 2 * 4 = 8\,rad/s$

8.

a. The energy in joule

$$E = UIt = 12 * 60 * 3600 = 2592000j$$

b. The mass required

$$m = \frac{E}{Lc} = \frac{2562000}{46 * 10^6} = 0.0563kg$$

9.

a. Linear magnification of a lens is the ratio between the image length (or image position) and object length (or object position).

b.

i. $m = \frac{80}{2} = 40m$

ii. $P + P' = 82$

$$P' = 40P$$
$$40P + P = 82$$
$$P = 2cm$$
$$P' = 80cm$$
$$\frac{1}{P} + \frac{1}{P'} = \frac{1}{f} \quad \frac{1}{80} + \frac{1}{2} = \frac{1}{f}$$
$$f = \frac{80}{41} = 1.95cm$$

10.

a. The resistance of a sample of unit length and unit cross-section area or the electric field per unit current density in the material.

b. The resistance

$$R = \rho\frac{l}{A} = 47 * 10^{-8} * \frac{1}{\pi\frac{(0.4*10^{-3})^2}{4}} = 3.74\Omega permetre$$

11.

a. The rate of change of displacement
Or: the rate of change of distance moved with time in a specified direction

b.

i. $P = F * t = 12 * 5 = 60\, kgm/s$

ii. $V = \frac{P}{m} = \frac{60}{6} = 10\, m/s$

12.

a. The volume of the cylindrical canister

$$V = \pi r^2 l = 3.14(0.45)^2 1.5m^3 = 0.954m^3$$

b. $n = \frac{PV}{RT} = \frac{21*1.013*10^5*0.954}{8.314*(273+22)} = 827moles$

c. $m = nM = 827 * 32 * 10^{-3} = 26.5kg$

13. The electric force $F_c = qE$

The magnetic force $F_m = qV \cap B$

The resultant force is zero $F = 0$

$$qE + qV \cap B = 0$$
$$E = -(V \cap B)$$
$$\begin{matrix} i & j & k \\ 0 & 5*10^3 & 0 \\ 0 & 0 & -1 \end{matrix}$$
$$E = 5*10^3 i$$

The magnitude of E

$$E = 5*10^3\ N/c$$

E must point in the opposite direction to the magnetic force

$F = qV \cap B$

Because$q > 0$ note that $E = -V \cap B$

$$Fe = qE$$
$$F_m = q \cap B$$
$$qE = q \cap B$$
$$E = VB$$
$$U = 5*10^3 j$$

The magnitude of U is $5*10^3\ m/s$

$$B = -(1T)K$$

The magnitude of $E$is 1T

$$E = 5*10^3 * 1 = 5*10^3\ N/c$$

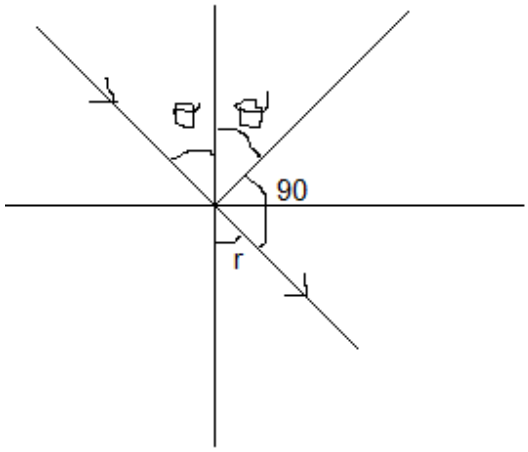
The direction of E is

$$E = 5*10^3 i$$
$$or \quad E = 5*10^3 j \cap K$$

14.

a. The process of confining the vibrations of the electric vector of light waves to one direction.
   #

b. Angle of polarization



$$\tan\varphi = \frac{n}{n'} = \frac{1.4}{1} \quad \varphi = 54.5°$$

φ is the angle of incidence. At this angle the reflected and refracted rays are perpendicular

$$r = 180° - (90° + 54.5°) = 35.5°$$

15.

a. Coefficient of kinetic friction

$$\frac{1}{2}mV_B^2 - M_k mgd = o \quad M_k = \frac{1}{2}\frac{(4.8)^2}{9.8 * 3} = 0.39$$

b. Work done by friction

$$\frac{1}{2}mV_B^2 = mgR + W_f$$

$$W_f = \frac{1}{2} * 0.2 * (4.8)^2 - 0.2 * 9.81 * 1.6 = -0.8352J$$

SECTION B

16.

a.

i. $V_o \perp B$

The force on the electron

$$F = eV_o \cap B(1)$$

Newton's second law

$$F = ma(2)$$

$$(1) = (2)$$

$$a = \frac{eV_o \cap B}{m}$$

$a \perp V_o$ Property of vector product.

And $F \perp V_o$ (1st relation)

Only the circle motion satisfies the above conditions.

Or $F = eVB(1)$

$$F_c = m\gamma_c = \frac{mV^2}{R}(2)$$

$$(1) = (2)$$

$$eVB = \frac{mV^2}{R}$$

$$R = \frac{mV}{Be} = \frac{momentum}{Be}$$

As m, v, B and e are *constant* , then R is a constant so the *trajectory is a circle*

ii. $V_o \ B$

$$F = qV_o \cap B$$

The magnitude of F is

$$F = eV_o B \sin\alpha$$

$$V_o \ B \ then \ \alpha = 0$$

$$F = eVB \sin 0 = 0$$

b.

i. $K\,E = e\,V = 1.6 * 10^{-19} * 200j = 320 * 10^{-19}j$

ii. $\frac{1}{2}mV^2 = qU \quad V = \sqrt{\frac{2*320*10^{-19}}{9.1*10^{-3}}} = 8.386 * 10^6\, m/s$

c.

i. The force $F = eVB = 1.6 * 10^{-19} * 8.386 * 10^{6} * 0.2N = 2.684 * 10^{-13}N$

ii. The radius $R = \frac{mV}{eB} = \frac{9.1*10^{-31}*8.384*10^{6}}{1.6*10^{-19}*0.2} = 238.477 * 10^{-6}$

iii. $t = \frac{T}{4}$

$$t = \frac{1}{4}\frac{2\pi R}{V}$$

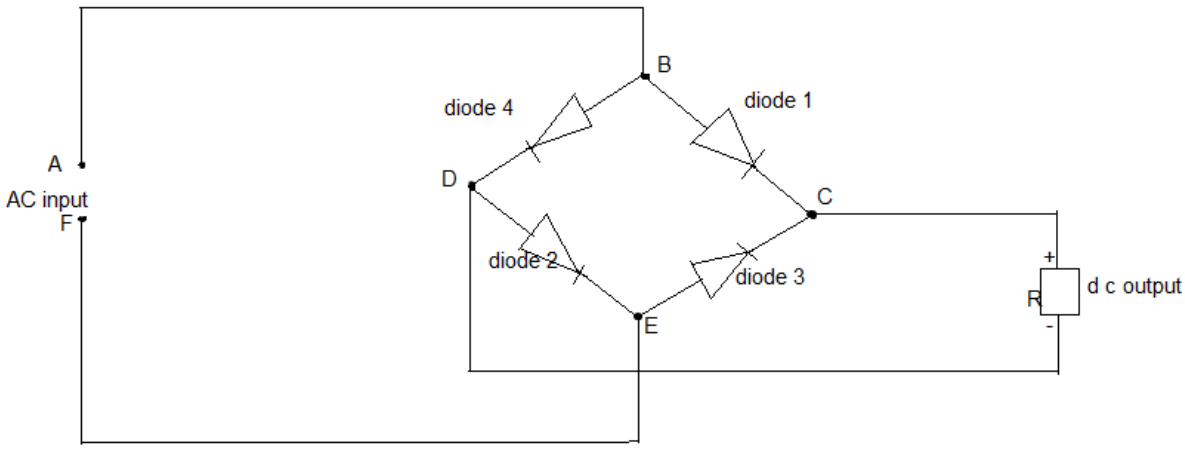
$$t = \frac{1}{4}\left(\frac{2 * 3.14 * 238.477 * 10^{-6}}{8.386 * 10^{6}}\right)$$

$$t = 44.646 * 10^{-12}s$$

17.

a. A semiconductor diode is an *electronic device* formed by a *P-n junction* where n is extrinsic conductor *doped positively*, n is extrinsic conductor *doped negatively* using as rectifier or switch.
Or
A semiconductor diode is a *P N junction* where P is an *extrinsic conductor doped positively*, n is *extrinsic conductor doped negatively*. It allows current to pass essentially
In one direction.

b.



If A is *positive during the first half cycle*, rectifier (diode) *1 and 2 conductor* and current take path ABCRDEF.
On the next half cycle, when *F is positive, rectifier 3 and 4 are forward biased* and current follows the path FECRDBA.
Once again, the current flowing through R is *unidirectional*. During both half cycles of input pd and a *dc output is formed*.

c.

i. $U_{R1} = U_{CC} - U_{BE} = (6 - 0.6)V = 5.4V$

ii. $I_B = \frac{U_{R1}}{R_1} = \frac{5.4}{10^5} = 5.4 * 10^{-5}A$

iii. $I_C = hf_E * I_B = 60 * 5.4 * 10^{-5} = 324 * 10^{-5}A$

iv. $U_{R2} = I_C * R_2 = 324 * 10^{-5} * 1000 = 324 * 10^{-2}V$

v. $U_{CE} = U_{CC} - U_{R2} = (6 - 324 * 10^{-2}) = 2.76V$

18.

a.

i. The force of the attraction between two given particles is inversely proportional to the square of their distance apart and directly proportional to the product of their masses.

ii. The region of space surrounding a body that has the property of mass in which any other body that has a mass will experience a force of attraction.

iii. $F = \frac{GMm}{R^2}$

$E_g = \frac{F}{m}$ Law of gravitation

$E_g m = \frac{GMm}{R^2}$ Gravitational field strength

$$E_g = \frac{GM}{R^2}$$

b. The gravitational potential at a point due to the gravitational field is defined as numerically equal to the work in taking a unit mass from infinity to that point.

$$V = \frac{GM}{R} = \frac{6.672 * 10^{-11} * 6.0 * 10^{24}}{6.4 * 10^6} = -62.55 * 10^6\, j/kg$$
$$= 62.55\, MJ/kg$$

c. The period of satellite is equal to the period of the earth as it turns about its oscis the satellite will stay over the same place on the earth while the earth rotates. On the satellite is in packing orbit.

$$F = \frac{GMm}{R_o^2}$$
$$F = \frac{mV^2}{R_o}$$
$$\frac{GMm}{R_o^2} = \frac{mV^2}{R_o}$$
$$V^2 = \frac{GM}{R_o}$$

The period $T = \frac{2\pi R_o}{V}$

$$V^2 = \frac{4\pi^2 R_o^2}{T^2}$$
$$\frac{GM}{R_o} = \frac{4\pi^2 R_o^2}{T^2}$$
$$R_o^3 = \frac{GMT^2}{4\pi^2}$$
$$R_o = \sqrt[3]{\frac{GMT^2}{4\pi^2}}$$

19.

a.

i. Is the focal length

$$\frac{1}{f} = (n-1)\left(\frac{1}{R_1} + \frac{2}{R_2}\right)$$

But for converging meniscus $R_2 < 0$

$$\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{2}{R_2}\right)$$

$$\frac{1}{f} = (1.6-1)\left(\frac{1}{12} - \frac{2}{28}\right) = 0.6\left(\frac{28-12}{336}\right)$$

$$f = \frac{336}{0.6(16)} \quad f = +35cm$$

ii. The position of image

$$\frac{1}{f} = \frac{1}{P_1} + \frac{1}{P'_1}$$

$$\frac{1}{P'_1} = \frac{1}{f} - \frac{1}{P_1}$$

$$\frac{1}{P'_1} = \frac{1}{35} - \frac{1}{45}$$

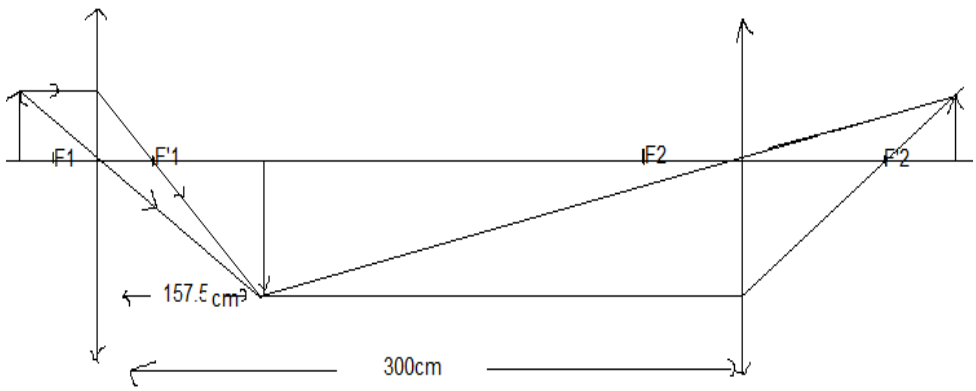
$$\frac{1}{P'_1} = \frac{45-35}{1575} \quad P'_1 = 157.5cm$$

iii. The size $m = \frac{P'_1}{P_1} = \frac{157.5}{45} = 3.5$

$$i = m * o = 3.5 * 5mm = 17.5mm$$

b.

i.



The image of lens 1 is inverted and is at $300cm - 157.5cm = 142.5cm$

To the left of 2nd lens

The position of the final image $\frac{1}{P'_2} = \frac{1}{f_2} - \frac{1}{P_2}$

$$= \frac{1}{35} - \frac{1}{142.5}$$

$$= \frac{142.5 - 35}{4987.5}$$

$= \frac{107.5}{4987.5}$ $P'_2 = 46.5cm$ To the right of the second lens

i. The final image is erected with respect to the original object

ii. $m_2 = \frac{P'_2}{P_2} = \frac{107.5}{4987.5}$

$$i_t = \frac{107.5}{4987.5} * 17.5$$

$$i_{td} = 5.7mm$$

20.

a. Radial acceleration

$$a = rw^2$$

$$thus\ a_1 = rw_1^2 \quad a_2 = rw_2^2$$

$$\Delta a = r(w_2^2 - w_1^2)(1)$$

One of the constant equations is

$$w_2^2 = w_1^2 + 2\alpha(\theta_2 - \theta_1) \ \ or\ \ w_2^2 - w_1^2 = 2\alpha(\theta_2 - \theta_1)$$

$$thus\ \ \Delta a = \ 2\alpha(\theta_2 - \theta_1)$$

As was to be shown

b. $\alpha = \frac{\Delta a}{2r(\theta_2 - \theta_1)} = \frac{85-25}{2*0.25*15} = 8\,rad/s^2 \ \ (angular\ acceleration)$

$$then\ \ a_c = r\alpha = 0.25 * 8 = 2\,m/s^2$$

c. The kinetic energy $K = \frac{1}{2} Iw^2$

$$\Delta k = \frac{1}{2} I(w_2^2 - w_1^2)$$
$$= \frac{1}{2} I 2\alpha(\theta_2 - \theta_1)$$
$$\Delta k = I\alpha(\theta_2 - \theta_1)$$

d. $I = \frac{\Delta k}{\alpha(\theta_2 - \theta_1)} = \frac{45-20}{8*15} = 0.208 kgm^2$

Or

a. $T\theta = DK \quad T\theta = \frac{1}{2} I(w_2^2 - w_1^2) \quad T = I\alpha \quad I\alpha\theta = \frac{1}{2} I(w_2^2 - w_1^2)$

$$2\alpha\theta = w_2^2 - w_1^2$$
$$2\alpha\theta R = Rw_2^2 - Rw_1^2$$
$$as\ a = Rw^2$$
$$2\alpha\theta R = a_2 - a_1$$
$$\Delta a = 2\alpha\theta R$$

b. $\Delta a = 60\, m/s^2 \quad \theta = 15\, rad, R = 0.25m$

$$\Delta a = 2\alpha\theta R$$
$$\alpha = \frac{\Delta a}{2R\theta}$$
$$\alpha = \frac{60}{2 * 0.25 * 15} = 8\, rad/s^2$$
$$w_1 = \sqrt{\frac{a}{R}} = \sqrt{\frac{85}{0.25}} = 18.44\, rad/s$$
$$V = RW = (0.25 * 18.44)\, m/s = 4.61\, m/s$$
$$w_o = \sqrt{\frac{a_o}{R}} = \sqrt{\frac{25}{0.25}} = 10\, rad/s \quad V_o = Rw_o = (0.25 * 10)\, m/s$$
$$a = \frac{V - V_o}{t} \quad since \quad \frac{\theta}{t} = \frac{w + w_o}{2} = \left(\frac{18.44 + 10}{2}\right) rad/s$$
$$= \frac{28.44}{2} rad/s$$
$$t = \frac{15 * 2}{28.44} = 1.055s$$

$$a = \left(\frac{4.61 - 2.5}{1.055}\right) m/s^2 = 2\, m/s^2$$

c. $\Delta k = \frac{1}{2}mV^2 - \frac{1}{2}mV_o^2 \quad since \quad V = RW$

$$\Delta K = \frac{1}{2}mR^2W^2 - \frac{1}{2}mR^2W_o^2 = \frac{1}{2}mR^2(W^2 - W_o^2)$$

$$since \quad W^2 - W_o^2 = 2\alpha\theta \quad and\ I = mR^2$$

$$therefore \quad \Delta E = \frac{1}{2}I * 2\alpha\theta = I\alpha\theta$$

Or

(c) $\Delta k = T\theta \quad T = I\alpha \quad \Delta k = I\alpha\theta$